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TUTORIAL

THINK TANKS AND THE NATIONAL SECURITY STRATEGY FORMULATION PROCESS: *A COMPARISON OF CURRENT AMERICAN AND FRENCH PATTERNS*

Robert Ranquet

This essay investigates the process by which national security strategy is formulated; more precisely, it will look at the specific input to this process from the organizations known as think tanks. It will also attempt to compare the ways think tanks influence the national security strategy formulation process in the United States and in France.

We did not have to wait long after the collapse of the Soviet Union to see the so-called New World Order both illustrated and challenged by very different experiences—the overwhelming coalition military victory in the Persian Gulf on one hand, and the pitiable procrastination of Western countries to cope with the Yugoslavian crisis on the other—send us contradictory messages that we must carefully decipher. The euphoria resulting from the former may well be as misleading as the acrimony we see arising from the latter.

As a result of this turmoil, formulating national security strategy has become a much more difficult and subtle exercise than it was under the traditional strategy of containment. The policymaker now has to integrate many different perspectives to get a better grasp of this increasingly complex art. Our investigation of the national security strategy process will use, as examples, two documents that were issued within a few months of each other. The first is the White House report to the Congress entitled: "A National Security Strategy of Engagement and Enlargement" (July 1994). The French government issued in March 1994 its "Livre Blanc sur la Défense," which, despite some meaningful differences from the White House report, shows many significant similarities to it. This white paper will therefore be used as an example of the practice on the French side.

A nation's national security strategy has a profound impact on its defense acquisition policies, not only in determining the types of systems procured and quantities (i.e. more mobility of forces versus less heavy defensive weaponry), but in the emphasis the nation places upon cooperative acquisition of defense equipment with its allies and friends, which results in an acquisition policy that favors cooperative developments of a new defense system. According to the Department of Defense Directive on Defense Acquisition, even more preferred to a new development is the procurement (including modification) of commercially available systems or equipment, additional production (including modification) of already developed U.S. military systems or equipment, or allied systems or equipment.

In a similar way, the 1994 French "Livre Blanc sur la Défense" strongly stated that: "No future major program on conventional weapons seems likely to escape the logic of (international) cooperation." This is clearly seen as a key factor in affording the future defense expenditures required to fulfill future military needs. Therefore, we should see strong pressure coming from acquisition communities, on both sides of the Atlantic, to make every possible effort to bring together more cooperative projects.

The methodology for this research has included contacts with numerous and various think tanks both in Washington, DC, and in Paris, interviews with senior political science and foreign policy analysts in some of these organizations, and a general survey of the national security strategy inputs from think tanks from 1992 through mid-1994.

The Formulation Products

As products of national security strategy formulation processes, the White House report will be refered to as "NSS 94," and the "Livre Blanc sur la Défense" as the white paper.

NSS 94 is required by law: The demand for this document originates in the Goldwater–Nichols Act of 1986. Its objective and content are codified in 50 USC 404a (see Appendix A). This report must each year assess the general frame for the national security strategy. Presumably it may also be useful in supporting the annual presidential budget request to the Congress. Actually, the last issues of the report have been affected by several changes in the administration, and have not met the requirement for an annual issue. As high-level political documents, such reports are not intended to assess precisely the detailed goals and means of the U.S. policy, but are limited to a broader view of the global national security strategy. It is up to more focused processes, such as the Bottom-Up Review in the military arena, to enter into this level of detailed information.

Captain (Armament Corps) Robert Ranquet wrote this article as part of his academic requirements at the Industrial College of the Armed Forces (National Defense University) in 1994-95. He is presently assigned to the French Embassy in Washington, DC, as the Attaché for Armaments.

The French white paper has the same broad objective of assessing the national security strategy. Because of the different balance of power between the executive and legislative branches of government in France, this white paper was written as an initiative of the prime minister, without any formal preset frame. Its official purpose is, as stated in its introduction: "To acquire a better understanding of our time and of the part played in it by the defense of our country. To place defense policy in the long-term perpective that is indispensable to it. To explain defense to the French people and rally their support" (p. 4). It is interesting to note that the previous white paper on defense had been issued 22 years previously. This long interval between the two may be explained by the relative stability of the global vision of the world during the Cold War period. It also probably reflects a traditional French consensus on the national strategic posture throughout the internal political changes of the period: the eventual adjustments to the strategy were made during periodic updates of the successive Military Midterm Planning Acts. But, the dramatic changes that occurred after the collapse of the Soviet Union obviously required an indepth re-examination of the national security strategy.

The purpose of the white paper is not primarily to inform the Parliament, but to achieve a broader education of public opinion. Like NSS 94, it has embedded a much larger concept of national security, departing from the merely military approach that prevailed a few years ago. Unlike NSS 94 and more like the Bottom-Up Review, it takes in fairly detailed consideration the military forces format. Beyond these technical distinctions, we can also note differences that deal more with differences in the approach of the security concept itself. For instance, NSS 94 pays special attention to the doctrine for the engagement of U.S. forces abroad, reflecting a major enduring concern among the American people.

It is also significant to note that NSS 94 discusses environmental issues, a subject absent from the French white paper. But, the white paper does discuss sociocultural issues, such as the relationship between the nation and its military institution, that are absent from NSS 94. It would be interesting, but also beyond the purpose of this essay, to investigate further the differences in the content of the two documents (see Appendix B): Let us simply suggest here that these differences are more dependent on contingent domestic political considerations at the time of their writing, than on more fundamental features of the so-called national characters.

The Formulation Processes

The U.S. Process

NSS 94, like its predecessors, was issued as the product of an interagency process, in which the National Security Council (NSC) plays the central role. A few senior officers in this organization were in charge of producing the drafts, and of acting as the linchpin of the process. The drafting began in July 1993, based on the strategic framework that was used in parallel for the Department of Defense (DoD) Bottom-Up Review. President Bill Clinton, who had been in office for six months, made it clear that the document

should also integrate some aspects from his own campaign platform. The first draft, ready by August 1993, was not circulated at once among the different agencies, but was used as a base for six major speeches on foreign policy that were delivered by the president and his cabinet members in September.

From the comments they received on these speeches, the NSC team produced a second draft, which was submitted to the other agencies by the end of October. Then at year's end, DoD was to submit its budget request to the White House. It became apparent that the two processes—budgeting and national security strategy formulation (which until then had operated separately)—had to be joined. So a third draft was prepared, reflecting the changes that then affected the strategic thinking of some decision-making layers at the White House and at the Pentagon.

Since it appeared unlikely that unanimous agreement would be achieved on this third version, a reduced team drafted a fourth version in March 1994, which eventually was approved and issued in July. Its publication, according to its writers, seems to have passed largely unnoticed, except perhaps by a very specialized public.

"Unlike the (theoretically) annual U.S. report, the French white paper was a rather exceptional event, and its elaboration followed a special *ad hoc* process."

The process took one full year, during which numerous interactions with other government processes had introduced painful iterations. This was probably not optimal for a process that must be repeated yearly. Nevertheless, we must recognize that NSS 94 was the first formulation by a Democratic administration of its national security strategy after the collapse of the Soviet Union, in a context of already declining military budgets at home, and several embarrassing situations (e.g., Somalia and Bosnia) developing abroad. Such may explain the difficulty.

The French Process

Unlike the (theoretically) annual U.S. report, the French white paper was a rather exceptional event, and its elaboration followed a special *ad hoc* process. In this case, the prime minister assigned the task on May 26, 1993, to a special interagency commission chaired by the vice-chairman of the Conseil d'Etat,[1] which gathered 20 high-ranking officials from the different concerned ministries, and 4 independent experts, among whom were the chairman of the French Institute for International Relations (IFRI) and the honour chairman of the Renault automobile firm (see Appendix C). This commission worked out its final document through the usual process of breaking down into several subcommissions, addressing issues such as: (a) the global outlook and the strategic trends, (b) Europe and Defense, (c) financial resources, (d) industrial base, and (e) human resources.

Meanwhile, the Ministry of Defense (MoD) itself organized its contribution through diverse working groups that fed the subcommissions with information and propositions that reflected the MoD's prospective.

These groups were able to incorporate numerous inputs from nongovernment sources, such as the major companies of

the defense industry. All this work was concluded within nine months, with a 130-page document that received a double preface from both the prime minister and the minister of defense. The document was approved on February 16, by President Francois Mitterand after a discussion within the "Conseil de Défense,"[2] and was presented to the defense committees of the two Parliament chambers on February 23. On the same day, the document was publicized in the media. As a white paper, this document did not have to be submitted for the Parliament's approval. Moreover, it was intended to provide a broad strategic framework for the future government work, and more specifically for the examination and enactment by the Parliament of the Military Midterm Planning Act (1995–2000 period) that was to be submitted at the 1994 fall session of the Parliament.

Think Tanks in the American Process

The American Think Tanks

It is not the purpose of this work to investigate in depth the nature of the American think tanks. Nevertheless, it is striking to recognize that any definition has difficulties embracing the variety of groups, companies, organizations, etc., that call themselves think tanks. James A. Smith has defined them as: "...[the] planning and advisory institutions..., the private, nonprofit research groups that operate on the margins of this nation's formal political processes" (Smith, 1993, p. xiii). Although this definition captures the essential features of most think tanks, some significant organizations do not fit it, but are nevertheless, without any doubt, real think tanks. For example, they include the Institute for National Security Studies, which is actually part of DoD, the *Armed Forces Journal International*, which belongs more to the media world, or Rand Corporation, which has many features of a "normal" advising and servicing company.

I would suggest here that, more than by their actual legal form, fiscal status, private or public ownership, or origin of funding, think tanks are characterized by their common purpose *to influence political processes from the margins*. The time horizon of their influence and their individual strategy to achieve this influence may vary from one to another, but all think tanks pursue that kind of purpose, and operate on the margin of the formal process, or, more precisely, at the junction of this process with some specific outside world. They play an indispensable role in formulating both the questions and the answers in the dialogue between two worlds: the world of informed public opinion and its experts, and the world of governmental bureaucracies. In this dialogue, where, more and more "... the most serious questions cannot even be posed, let alone answered, in the language of common sense," they act as intermediaries and interpreters (Smith, 1993, p. 238). They both feed the bureaucracy with the ideas that bureaucrats have no time to dig out by themselves (ideas brokers, as Smith describes them), and to circulate these ideas to build public consensus. They "... are the principal arteries through which knowledge flows and is absorbed, like oxygen, into the bloodstream of political life" (Smith, 1993, p. 238).

What Were the Issues Raised, and How?

The Role of the United States in the World. The fundamental issue that must be addressed in the formulation of a national security strategy is what this nation sees as its role in the world. This has been and still is a very controversial issue in the United States. The classic opposition of the isolationist view versus the globalist view has been raised again in the aftermath of the Cold War, with shifting emphasis on the economic, social, or cultural aspects of the debate. More precisely, the debate has shifted from whether or not the United States should withdraw to its continent and concentrate on domestic problems, to what precise National interests are at stake abroad and to how much this nation is willing to pay for the preservation of these interests. Think tanks have widely discussed this issue. The conservative Heritage Foundation has traditionally advocated less exclusive American engagement, as assessed, for example, by Doug Seay (1992):

> America need not, and will not long wish to, continue to assume the principal burden for keeping order around the world. But it does have an interest in the maintenance of that order. Only by encouraging its allies, past and future, to assume their proper share of the burden can it safely relinquish the lion's share of the burden.

At the same time, the Democratically oriented Brookings Institution proposed a more assertive stance toward global engagement, by promoting, for example, William Perry's concept for a cooperative security:

> A cooperative security regime is designed to minimize any underlying military causes for such conflicts, to deter rogue nations from initiating such conflicts, and if deterrence fails, to provide a multinational military force to defeat any aggressor nation.

From the libertarian side of the political continuum, the CATO Institution warns against any American involvement in what are seen as outside problems, thus bringing to the United States undue risks and excessive government burden (Ravenal, 1991):

> In the emerging era of international relations, even great nations—even the "sole surviving superpower," if one insists on that—will do better to adjust to the conditions of the international system than to perpetuate attempts, however attractive and apparently constructive, to control the course of events in the world.

A significant majority agrees on the necessity of promoting regional solutions as an alternative to U.S. intervention (Conry, 1994), by transferring more responsibilities to regional powers and relying more on regional security structures. Institute for National Security Studies senior fellow Patrick M. Cronin argues that "the best course is to pursue U.S. interests internationally through a concert of power with our key allies," in a Wilsonian reminiscence (Cronin, 1993).

All these ideas, the contradiction of which is at the core of the most existential

problem facing the United States, are echoed in NSS 94: ... it is clear that we cannot police the world; but it is equally clear that we must exercise global leadership" (p. 5).

The National Interests. Even if "global leadership" is a generally well-accepted (appealing yet vague) American ideal, it is hard to deduce from NSS 94 what precisely are the national interests that we are protecting by exercising this global leadership, especially at the eventual cost of American lives. Think tanks have brought some tentative answers to this question.

Some answers are in the negative form: "Instead of assuming grave risks when vital American interests are not at stake, the United States should distance itself from regional disputes that could go nuclear," the CATO Institute warns policymakers (Carpenter, 1993, p. 1). Some Wilsonian interests, which had become favorites of American foreign policy in past admistrations, do not appeal to the Heritage Foundation: "America does not have endless resources to squander on some open-ended crusade for democracy and human rights" (Holmes, 1994, p. 7).

Some conclusions are more assertive: Policymakers should classify the national interests in thinkable categories, such as "vital, important, and marginal," as proposed by the Heritage Foundation (Holmes, 1994). This approach, also stressed by military-academic institutions such as the National Defense University, may be too rational for the accommodation of political flexibility. This may be why NSS 94 prefers to focus on broader objectives, such as "Enhancing Our Security," "Promoting Prosperity at Home," and "Promoting Democracy," without paying too much attention to the real nature of the objective links between these generic goals and the actual national security concerns. One could argue that these broad objectives would allow any sort of foreign or domestic, economic or military issue the government deemed important to be called a "national security" issue. As a matter of fact, NSS 94 embraces a very wide range of preoccupations in the generic category of national interest: For example, a strong emphasis in the document is put on environmental issues, echoing M. Renner of the WorldWatch Institute:

> Environmental threats with the potential to erode the habitability of the planet are forcing humanity to consider national security in far broader terms than that guaranteed solely by force of arms (Renner, 1989, p. 7).

The Resources. At the same time, this broad picture allows NSS 94 to remain very elusive about what should be the appropriate answer to a threat directed against these interests. This may be, after all, good strategy, according to Sun Tsu's aphorism: "All warfare is based on deception" (1963, p. 66). And it also preserves the possibility for any necessary adjustment of the policy in the difficult art of resource allocation. But although the document

> ***"But although the document prudently avoids any precise assessment of the effective forces format that would meet the requirements of the strategy, it wisely points at the generic source of any national power: the economy."***

prudently avoids any precise assessment of the effective forces format that would meet the requirements of the strategy, it wisely points at the generic source of any national power: the economy. Answering the claim by Norman D. Levin of Rand for "[a] greater link between U.S. foreign policy goals and domestic, especially economic, objectives" (1994, pp. xv–xvi), NSS 94 stresses such economic objectives as enhancing American competitiveness, promoting the partnership with business and labor, and enhancing access to foreign markets, in a way that leaves little doubt about the will of the government to actively invest itself in the promotion of the American defense industry.

"Top-level political personalities are more likely to be reached at think tank conferences or symposia, where they deliver keynote addresses or after-dinner speeches, and listen to selected panelists."

How Do American Think Tanks Work?

One could deduce, from this general survey of the correlation between the issues discussed by think tanks in their publications and the content of NSS 94, that these organizations create and inject ideas in the policy process mainly through pamphlets or books. This conclusion would overestimate the influence of these publications. These documents are side-effects, if not residues, of the real value-added activities of think tanks as "ideas brokers," "brains brokers," and "personal networks operators." Let us describe briefly these categories.

The Ideas Brokers. This title of the very well-informed book by James A. Smith (1993) captures much of what is the purest expression of their activity. Whether think tankers create original ideas (which is arguable), or more likely bring up new combinations or new applications of preexisting ideas, their output is basicaly conceptual. These archetypes of the "symbolic analysts" (Reich, 1992) deliver their conceptual product to numerous customers: first of all to the senior officers, civil servants, or staffers who are the concrete actors of the policy process through numerous government departments, bureaus, committees, or agencies. Then their ideas are purveyed to the top ranking political personnel of the government: secretaries or under-secretaries, chairpersons of diverse committees, and other special advisors. And finally they submit their product to public opinion, or at least to the informed part of it that constitutes the defense community.

Many channels are used for this activity, and are adapted to each objective. Top-level political personalities are more likely to be reached at think tank conferences or symposia, where they deliver keynote addresses or after-dinner speeches, and listen to selected panelists. Organizing such events is therefore a large—and often lucrative—part of think tank activity. The intermediate level of senior actors is often treated more in depth: focus workshops and seminars that gather restricted caucuses allow think tankers to interact with them, to trade ideas and propose views. This private interaction is often supplemented by more public and official events, such as testifying before Congressional committees. The opportunity for such direct interaction naturally depends

on the degree of proximity or of political sympathy between the think tank and the current administration. This explains why, for example, DoD's analysts from the Institute for National Security Studies (INSS) or people from the Brookings Institution may have been more active than others during the Democratic administration's preparation of NSS 94.

This is not to say that opposition think tanks have remained inactive: the Heritage Foundation, for example, has been very active in proposing its own views of the national security strategy (Holmes, 1994) to such powers as Rep. Newt Gingrich, Speaker of the House of Representatives. This approach has included proposition of fully crafted pieces of legislation, such as a pending bill titled the "National Security Act of 1995."

All these private meetings, seminars, or conferences give birth to another important activity: publication. Articles, books, compilations of conference presentations, etc., are a significant part of think tank activity, and of their revenue (up to 50%). But they are not so much the channel through which think tanks operate, as they are the signs by which the outside observer may track their direct interactive activity.

The Brains Brokers. Think tanks do not exist on ideas alone. They also require brains, usually associated with individuals. Staff members often are migrants from senior political analyst positions or derive from diverse kinds of fellowship association in think tanks; some staff members come from senior political positions within the administration or the Congress, and vice versa. This provides a privileged way for think tanks to influence the policy-making process. The "revolving door," as this practice has come to be called, has been used intensely. Pr. Edward Warner came from Rand to head the Bottom-Up Review process at the Pentagon as Assistant Secretary for Strategy and Requirements. Walter Slocombe, presently Under Secretary for Policy, came from Brookings. Secretary of Defense William Perry himself elaborated his concept of cooperative security, in association with John D. Steinburger and Ash Carter (Assistant Secretary for International and Security Policy), as a distinguished fellow at Brookings.

The American Enterprise Institute hosts such distinguished fellows as former Defense Secretary Dick Cheney or United Nation Ambassador Jeane Kirkpatrick, while the Center for Strategic and International Studies (CSIS) has welcomed such individuals as Henry Kissinger, Zbigniew Brzezinski, both National Security Advisers and a former Secretary of State, and James Schlesinger, who headed two Cabinet departments. And it is likely that the new Republican 104th Congress will give the Heritage Foundation the opportunity to see some of its analysts play a direct role on Capitol Hill, where they will be able to implement the policies that they had been designing for years through their "Mandate for Leadership" (Butler, Sanera, & Weinrod, 1984).

"But think tanks are the places where such individuals find the opportunity to formulate, elaborate, confront, enrich, validate, and finally diffuse their ideas..."

It would be inaccurate to presume that these individuals and their ideas are mere products of think tanks. But think tanks

are the places where such individuals find the opportunity to formulate, elaborate, confront, enrich, validate, and finally diffuse their ideas through their collaboration with the regular scholars that constitute the permanent core of the organizations. Think tanks provide them with the opportunity to reach a selected audience. And former top-level officials bring to think tanks that host them some priceless aura that ensures the success of the events they support. Like a symbiosis, this often-enduring relationship between these individuals and think tanks benefits both parties.

"...I would argue that this disconnection between the administration and the think tanks network may lead to, or be the sign of, an impoverishment of the relationship between the current government and the idea-creative layers of the society."

Think Tanks as Personal Network Operators. Beyond their functions as idea and brains brokers, think tanks possess one further, and fundamental, feature. As they organize private meetings, restricted seminars, and public symposiums, and trade senior individuals with the administration, think tanks build and operate networks. They link different worlds: the government world, the business world, the academic world, and the military world, whose preoccupations and even languages differ so much from each other. But ideas do not circulate by themselves. Think tanks provide the venues—physical or virtual[3]—where people periodically gather and interact. I would suggest that it is for and from these interactions that think tanks build the networks that constitute the very base of the policy-making system. This activity passes largely unnoticed and is nearly impossible to trace.

What Was the Overall Contribution to NSS 94?

Curiously enough, all the actors in the process that were interviewed said that NSS 94 received very few direct contributions from think tanks. However, we have seen that the issues themselves that were addressed in the document have been comprehensively discussed and published by several think tanks. It seems therefore that all this activity has taken place either beside or much ahead of the formulation of the document itself. The chaotic process that we described earlier may be responsible in part for that shortcoming: it seems that the administration was too busy struggling with its own internal frictions to pay much attention to the outside world. Should we view this as the result of excessive self-confidence on the part of the administration? Or on the contrary, did policy makers consider this writing as a futile and formal exercise that had to be achieved at the least intellectual cost in order to concentrate on more short-term but really burning issues, such the changing relationships with Russia or China, or the Bosnia crisis?

Whatever the cause, I would argue that this disconnection between the administration and the think tank network may lead to, or be the sign of, an impoverishment of the relationship between the current government and the ideas-creative layers of the society. We must look to the Congress and the Clinton Administration to see whether this relationship is revital-

ized and to stress the need for a renewed and enhanced political debate. In any case, every think tank analyst could endorse this claim by Rand's Ronald D. Asmus (1994, p. ix): "If the United States is to find a new post-Cold War consensus, then airing and debating these views and differences is a healthy and inevitable part of building this new consensus."

THINK TANKS IN THE FRENCH PROCESS

WHO ARE THE FRENCH TANKS?

Some basic distinctions exist between French think tanks and their American counterparts. We may define them in various ways. The more efficient is to come back to Smith's definition (1993, p. xiii): "the private, nonprofit research groups that operate on the margins of the nation's formal political processes." On each point of this definition, we can find a wide range of different patterns for these think tanks in France, as well as in the United States.

Let us consider first the status of the group. We shall find groups ranging from the totally private AERO company, and "Loi de 1901" nonprofit associations such as the Center for Strategic Research (CREST)[4] or foundations such as the recent Fondation pour les Etudes de Défense, to government in-house groups such as the Defense Acquisition Agency's (DGA) Center for Defense Analysis, or the Délégation aux Affaires Stratégiques (DAS).

As in the United States, a number of think tanks are university-linked; but those are generally very limited teams (and sometimes single individuals). Except perhaps for Pr. Schmitt's studies in the defense economy field at Paris-Porte Dauphine University, these teams do not usually make a significant contribution.

The Institute for National Security Studies, hosted here by the National Defense University, has a near equivalent in the Groupes d'Étude et de Recherche hosted by the Center of Higher Armament Studies in Paris.

Some think tanks are more closely linked to the political world: various foundations, "Centre d'Études," forums or "Carrefours de Réflexion" act as idea providers, diffusers, or catalysts for groups or individuals pursuing some political objectives. In some cases, they seem to be more like temporary refuges where out-of-office senior political personal find an active rest before a hypothetical return to power.

What are the sources of funding for these groups? Here again, the answers vary. Many depend on government contracts for the major part of their activities. Here, they clearly differ from American think tanks, many of which rely mainly on endowments and private funding, or are partly self-funded through profitable publications and conferences. French tradition does not encourage such private interest in national security thinking.

> **"French tradition does not encourage such private interest (endowments and private funding) in national security thinking."**

THE OBJECTIVES OF FRENCH THINK TANKS

Do French think tanks mainly pursue only educational and research objectives, or do they also try to influence the policymaking process? Here also, like American think tanks, their aims vary:

some sponsor pure thinkers (if there are any in this world)—the Woodrow Wilson Scholars nearly mirror the Centre National de la Recherche Scientifique researchers in foreign and defense policy; others are openly partisan, such as the left-wing Institute for International Relations and Strategy (IRIS) and the right-wing Center for Prospective and Strategic Studies (CEPS). We must keep in mind that the French Parliament is, traditionally if not constitutionally, much less involved, or at least at a lesser detailed level, in foreign policy and national security policy than its American counterpart. There is a strong tradition under the institutions of the French Fifth Republic to recognize the very preeminent prerogative of the president in this area. As a result, the French system allows the executive bureaucracy to shape these policies without so much interference from either the political parties, or the Parliament. The need for circulating ideas is therefore less important and, consequently, the input from French think tanks much less visible in the policy process.

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Fewer think tanks, smaller in size and with fewer financial resources, are less influential in the policy-making process—this is how French think tanks compare to U.S. ones, which have been quite properly pictured as a "quintessentially American" institution (Smith, 1993, p. xiii).

Did French Think Tanks Contribute to the White Paper?

There is no need here to look in great detail at how French think tanks usually operate: by and large, they use the same means as their American counterparts. Seminars or conferences, testifying before government or Parliamentary commissions, publications—French think tanks do all these, although on a lesser scale, because of their lower visibility in the political landscape, and the relative lack of interest shown them by the administration.

Think tanks published several books or articles during the preparation of the white paper. For instance, in a special issue of the *Défense Nationale* journal, chairman of Comité d'Études de Défense Nationale Paul-Marie de la Gorce suggested a broad national security strategy framework. He emphasized the need of defining first the national interests: "[The threats] can only be defined relative to those interests that have to be defended, and one should begin by defining these latter" (1993, p. 10). His articulation of the geo-strategic context relied on four premises: (a) the existence of one military superpower; (b) the existence of several nuclear powers; (c) the new instability of the Eurasian continent, from the Adriatic sea to Chinese borders; and (d) the growing instability of those "strategic zones where political, and eventually military, instability comes from economic and social crises, with their ethnical and religious spillovers" (la Gorce, 1993, p. 15).

From these premises, de la Gorce derived several propositions, specially advocating for nuclear deterrence and conventional force projection capacities.

In the same issue, former chairman of the Fondation pour les Études de Défense Nationale, Pierre Dabezies, published "Réflexions sur le Livre Blanc" (1993). His main argument stressed the need to substitute an "approach by the political project" for a mere static assessment of national interests. From that perspective, he discussed how cross choices between different—and maybe contradictory—projects muddle the French strategic landscape: the pursuit of the global "new world order," the tightening of links with NATO, the building of the European Union and of a hypothetical' foreign and security common policy" being among the most burning issues.

These discussions were clearly in the scope of the white paper. Nevertheless, they were more broadly political, editoriallike assessments than scholarly studies usually expected from think tanks. Further, there was no indication that these pieces reflected anything more than personal and selective views—not being part of more broad research within any organized framework.

An exception is the book published by CREST director Alain Baer titled: *Thoughts on the Nature of Future Defense Systems* (1993). This book originated in the work of one of the research groups that operate in connection with the Center for Higher Armaments Studies.[5] It presents a comprehensive approach of new defense concepts, both in terms of organization and material, especially stressing the importance of real-time intelligence. It proposed creation of a permanent National Security Council, on the American model, and a new concept for the organization of the forces, which would be articulated between interior and exterior forces, according to whether their vocation would be to defend the metropolitan territory, or to be projected abroad. Alain Baer also provided a fairly extensive study of the current "military revolution" and of its implications in terms of technology and weapons systems.

This study was clearly original among other more political and circumstantial publications, and was probably the only one that could be considered as a think tank product.

What Has Been the Real Input from Think Tanks to the White Paper?

Specifically in the case of the white paper, it appears from the interviews completed that the *ad hoc* commission had very little input from think tanks: (a) Just one independent expert in the commission itself was the head of a think tank (the French Institute for International Relations); (b) no request for any advice was ever made by the commission to think tanks themselves, although the commission heard many experts *intuitu personae*; and (c) the commission received several spontaneous contributions from diverse organizations, such as professional syndicates or corporative groupments, but none of them standing think tanks.

"[The book] presents a comprehensive approach of new defense concepts, both in terms of organization and materiel, especially stressing the importance of real-time intelligence."

As in the case of the writing of NSS 94, some external factors may have contributed to keeping think tanks apart from

the policy process. For example, it has been largely noticed that this white paper was a product of the so-called "cohabitation," which is a strange situation of government in which a left-wing president shares the power with a right-wing prime minister. This kind of political compromise seems to have become a French "favorite" for nearly 10 years. If it has led to some serious confrontation on domestic issues, it has never seriously affected the unity of action of the government on foreign policy and defense issues. But, it may have influenced the autonomy of thought of the commission and its ability to launch into more creative strategic thinking. The writers of the white paper could therefore have perceived their assignment as not so much to bring up new ideas (which could have justified resorting to think tanks), but to achieve a balanced and smooth product that could get the broadest political assent possible.

"[The French administration] therefore has less inclination than the American one to look outside for ideas or conceptual achievements that it presumably can provide on its own."

Comparison of the Two Patterns

In both France and the United States, organizations that more or less fit the description of a think tank usually operate at the margin of the national security strategy-making process. These organizations are much more common in the United States and enjoy a higher visibility, because of their number, size, and traditional implication in political life.

Specifically concerning NSS 94 and the French white paper, think tanks seem to have had little direct input. In the United States, where they have nevertheless been very active in debating the major issues related to the national security strategy, they probably suffered from a lack of interest by the administration for their input. But this current loose relationship between U.S. think tanks and the administration is unusual. It is, however, the rule in France, where these institutions are traditionally kept outside the political process by an administration more confident in its own capacity to elaborate the policy. Among other reasons, this major difference between the two countries may be related to the history of their form of government. This observation by Smith seems true today: "... in countries with older civil service tradition and fewer political appointments, experts could be found in the bureaucracy much earlier than they could in the American system, where nonpartisan experts typically had to be housed on the outside" (1993, pp. 228–229). From that perspective, the long American tradition of distrust for a centralized government and the chronic instability of the upper layers of the administration (because of the great number of short-lived political appointees), have probably contributed to enhance and sustain the importance of think tanks in political life. These organizations assume a central function in improving the continuity of thought of the nation, and in helping elaborate political wisdom. Yet, if we agree with Smith's statement (1993, p. xi) that "[t]here is something troubling about the relationship among experts, leaders, and citizens that

tends to make American politics more polarized, shortsighted, and fragmented—and often less intelligent—than it should be,"[6] we may assume that even think tanks fall short of the task.

On the French side, think tanks are granted only a little influence in policy making. We have already stressed the major feature of the French administration as a very intellectually autonomous one: several centuries of government service, a high ideal of public service, a long history of centralized power from Colbert up to the present, make this administration think of itself as the one of the best and the brightest. It therefore has less inclination than the American one to look outside for ideas or conceptual achievements that it presumably can provide on its own.

We have described American think tanks as key actors in building the personal networks that vitalize the policy-making process. In France also, personal networks are fundamental in the policy process; the difference is that these networks, in a sense, preexist through the links that gathered many senior military or civil servants from their education in the two or three major institutions that form the French élite (Alumni of the École Nationale d'Administration or of the École Polytechnique, for example, operate very far-reaching and powerful networks that cross the highest layers of the political, administrative, and business worlds.) Therefore less room exists in that function for organizations such as think tanks. I would suggest here that this pattern of policy making will soon find its own limits: As the European integration process goes on, these education-based national networks will no longer operate at a sufficient level. Since the "Euro-Elite" will obviously be more diversified than the national French one, there certainly will be a need for new links and venues where the "Eurocrats," as they are sometimes called (a bit pejoratively), will be able to interact and forge together their political thought.

Conclusion

As David M. Ricci states (1993, p. 182): "Think tanks fit somewhere into public life, but no one knows exactly where that is."

This essay has tried to investigate how they fit into the national security strategy formulation process. How they operate in this very specific field in the United States, compared with the French way, suggests that these patterns do not only depend on internal features of these organizations, but also reflect major traits of the policy-making process. The importance of their input in the U.S. process, their visibility in political life, and their very existence are fundamentally linked to the characteristics of the American political system. This is confirmed by contrast with the French example, and this observation agrees with the thesis expressed (from a political science perspective) by Ricci (1993) and from a more historical one by Smith(1993). Smith finds think tanks a specific solution to the no-less-specific problem of the American policy-making system. More precisely, they help to build

"This essay has tried to investigate how [think tanks] fit into the national security strategy formulation process."

and operate the personal networks that facilitate the complex interactions between and among the industrial, business, academic, and political worlds; and then between these civilian entities and the administration and the Congress, as the two major protagonists.

Finally, I would suggest that this hypothesis could be confirmed by observing the policy-making system of the European Union: In the same way that think tanks emerged in the United States after World War II, and spectacularly increased in the 1970s and 1980s, accompanying the increase in the federal government,[7] we should expect similar organizations to emerge and develop at the periphery of the European Commission in Brussels, following the implementation of the Maastricht treaty.

APPENDIX A - EXTRACT FROM 50 USC 404A

Each national security strategy report shall set forth the national security strategy of the United States and shall include a comprehensive description and discussion of the following:

(1) The worldwide interests, goals, and objectives of the United States that are vital to the national security of the United States.

(2) The foreign policy, worldwide commitments, and national defense capabilities of the United States necessary to deter aggression and to implement the national security strategy of the United States.

(3) The proposed short-term and long-term uses of the political, economic, military, and other elements of the national power of the United States to protect or promote the interests and achieve the goals and objectives referred to in paragraph (1).

(4) The adequacy of the capabilities of the United States to carry out the national security strategy of the United States, including an evaluation of the balance among the capabilities of all elements of the national power of the United States to support the implementation of the national security strategy.

Appendix B - Structural Comparison of the Two Basic Documents

A National Security Strategy of Engagement and Enlargement	Livre Blanc sur la Engagement Défense 1994
Preface (W. J. Clinton)	Préface (E. Balladur)
	Préface (F. Leotard)
I Introduction	Introduction
	First Part: The Strategic Context 1. International Prospect
II Advancing Our Interests	2. Defense Policy Objectives
	2.1 Defending France's Interests
	2.2 Constructing Europe
	2.3 Implementing a Global Conception of Defense
	3. International Reference Framework
	3.1 Toward a New European Security
	3.2 Reinforcing U.N. Role
	3.3 Bilateral Cooperation
II.1 Enhancing Our Security	4. Our Defense Strategy
Maintaining a Strong Defense Capability Major Regional Contingencies Overseas Presence Counterterrorism ... Combatting Terrorism Fighting Drug Trafficking Other Missions	5. The Capabilities of the Armed Forces

Deciding When and How to Employ U.S. Forces	3.4 Arms Control, Disarmament and Nonproliferation Treaties
Combatting the Spread and Use of Weapons of Mass Destruction	
Nonproliferation and Counterproliferation	
	id
Strategic Nuclear Forces	
Arms Control	
Peace Operations	
Strong Intelligence Capabilities	9.5 Organization of Information
The Environment	
	6. Human Resources
2.2 Promoting Prosperity at Home	9.4 Economic Defense
Enhancing American Competitiveness	7. Arms Policy and Industrial Strategy
Partnership with Business and Labor	7.3 New State/Arms Industry Relationship
Enhancing Access to Foreign Markets The NAFTA Asia Pacific Economic Cooperation Uruguay Round of GATT U.S.–Japan Framework Agreement Expending the Realm of Free Trade	7.4 An Export Policy
Strengthening Macroeconomic Coordination	
Providing for Energy Security	
Promoting Sustainable Development Abroad	
Promoting Democracy	
	8. Defense Effort

III Integrated Regional Approches Europe and Eurasia	
East Asian and the Pacific The Western Hemisphere The Middle East, Southwest, and South Asia Africa	
	9. Defense and Society
IV Conclusions	Conclusion

APPENDIX C - COMPOSITION OF THE WHITE PAPER COMMISSION

Chairman
Marceau Long, *vice-chairman of the Conseil d'État*

Office of the Prime Minister
General Schmitt, *special advisor*
Préfet Marland, *advisor for domestic affairs*
Rear Admiral Lecointre, *head of military staff*
General Lerche, *head of Secrétariat Général de la Défense Nationale*

Defense Ministery
M. Donnedieu de Vabres, *special assistant*
Admiral Lanxade, *chief of the joint staff*
General Conze, *head of DGA (Defense Acquisition Agency)*
M. Roussely, *general secretary for administration*
General Rannou, *head of military staff*
M. Mallet, *director for strategic affairs*

State Department
M. Racine, *special assistant*
M. Guéhenno, *head of CAP (Center for Analysis and Prospective Studies)*
M. Barry-Delongchamps, *director for strategic affairs*

Ministry of Treasury
Ms. Bouillot, *budget director*

Ministry of Interior
Préfet Riolacci

Ministry of Research
M. Paolini, *special assistant*

Ministry of Industry
M. Lombard, *director for industrial strategy*

Ministry of International Cooperation
M. Pouillieute, *head of staff*

Atomic Energy Agency
M. Baléras, *director for military applications*

Independent Experts
M. de Montbrial
M. Levy
M. Prada, *Cour des Comptes (General Accounting Office)*
Ambassador Robin

APPENDIX D - INTERVIEWS COMPLETED

In the U.S.:

Col. Richard Barry, *Institute for National Security Studies*

Bruce Blair, *The Brookings Institution*

Lawrence DiRita, *The Heritage Foundation*

Capt. Keith Hans, *National Security Council Staff*

Patrick Glynn, *American Enterprise Institute*

Robert Grant, *director U.S. CREST*

Eric Peterson, *vice-president, Center for Strategic and International Studies*

In France:

Col. (Armt. Corp) Patrick Auroy, *Livre Blanc Commission Secretariat*

General (Armt. Corp) Alain Cremieux, *former Commandant of the Center for Higher Armament Studies (CHEAr)*

Jean-Francois Delpech, *director of the Center for Strategic Research (CREST)*

General Eric de la Maisonneuve, *director of the Foundation for Defense Studies (FED)*

Thierry de Montbrial, *director of the French Institute for International Relations (IFRI)*

End Notes

1. In French government institutions, the "Conseil d'État" is an equivalent of the U.S. Supreme Court, in its role of judging the disputes arising between the individuals and the state. It also enjoys substantial legislative and regulatory powers.

2. This structure has a function and a composition similar to those of the U.S. National Security Council. But unlike the NSC, it has no substantial supporting bureaucracy.

3. The Heritage Foundation operates a 24-hour online computer service having an explicit name: "Town Hall—The Conservative Meeting Place."

4. It may be worth noting that CREST has the rather exceptional feature of having a U.S.-based sister organization, US CREST, in Arlington, VA, whose vocation is specifically to work on transatlantic issues.

5. This institution is, although on a lesser scale, an equivalent of the Industrial College of the Armed Forces.

6. The Research Institute of the Western European Union headed by John Roper in Paris may represent a prototype (although certainly specific in its belonging to the WEU) of these future Euro-think tanks.

7. The increase in the number of White House staff is a good indicator of this rise of "big government": the staff comprised just 48 people in 1944 under President Franklin D. Roosevelt. It rose to 275 in 1960 under President Dwight D. Eisenhower, and increased to 540 in 1975 under President Gerald Ford. Today, the Executive Officer of the President consists of about 2,000 individuals.

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RETHINKING TWENTY-FIRST CENTURY ACQUISITION: *EMERGING TRENDS FOR EFFICIENCY ENDS*

Conrad S. Ciccotello, Steve G. Green, and Martin J. Hornyak

Understanding three emerging public-sector trends—privatization, promotion of competition, and continuous process improvement—is essential to achieve efficiencies sought by acquisition managers in the 21st century.

With the collapse of the Soviet threat and a steady decline of available resources, the Department of Defense (DoD) is adapting to unprecedented change. The military services in the 1990s have introduced profound changes to DoD's financial and resource management systems, compared to when former Secretary of Defense Robert McNamara first introduced the Planning, Programming, and Budgeting System (PPBS) (Hough, 1992). The Defense Performance Review (DPR), Chief Financial Officer's Act (CFO), and Government Performance and Results Act (GPRA) all generate policy and legislation demanding considerations and measurement of efficiency in DoD operations. Public functions that fail to meet the call for improved efficiency are being privatized or consolidated away.

Acquisition management is not immune from these demands. Program managers must understand and take advantage of these new initiatives to improve efficiency or face possible elimination as public employees. Here we examine three current public-sector management policy trends: (a) privatization of functions, (b) promotion of competition between government entities or civilian contractors, and (c) continuous process improvement. For program managers, determining which policies to consider and implement will be a daunting challenge. To be successful, an acquisition manager must be aware of policy initiatives and develop means of assessing which policy options are best. Here we outline some current policy initiatives affecting the acquisition community, then investigate several assessment alternatives

that make use of applicable private-sector business metrics for policy evaluations.

The Environment

The American defense budget has been shrinking in real terms since the mid-1980s. From 1985 through 1997, DoD will experience overall defense budget cuts to equal 42% (including a 30% reduction in personnel), overseas base closures of 35%, and U.S. base shutdown of 15% (DoD Comptroller, 1994). Despite these cuts, the requirements to support critical national interests in various regions of the world remain. With budgets shrinking and requirements steadily growing, DoD has logically focused on initiatives to increase efficiency. Acquisition management has seen a host of formal acquisition improvement, streamlining, and reform initiatives that suggest or direct how to improve the way in which weapon systems are procured (Harman, 1995). Most recently the Federal Acquisition Streamlining Act of 1994 culminated a concerted effort to place reform of government procurement at the top of the list of national priorities (van Opstal, 1995).

Despite these reform attempts, numerous factors—such as DoD's complex organizational structure, lack of incentives to improve operations, dynamic requirements, and shifting direction—hamper efforts to improve acquisition management. A recent study requested by the Office of the Under Secretary of Defense for Systems Integration investigates the conflicts of roles and incentives inherent in acquisition management (Fox, Hirsch, & Krikorian, 1995). The study highlights critical issues within the defense acquisition culture, and suggests that acquisition program managers top priority is keeping their programs alive and moving through the acquisition process. This can occur even when the program's completion may not be consistent with larger interests. A 1992 General Accounting Office (GAO) study concludes that traditional targets of acquisition reform including performance shortfalls, schedule delays, and cost increases, are the logical consequences of the current acquisition culture (GAO/NSIAD-93-15, 1992).

Public sector organizations often have problems achieving efficiency without compromising mission. Prager (1994) argues the public sector is inefficient because of "...a lack of political will to establish efficiency as a high-level priority of government operations." He argues that public sector management is not given with sufficient flexibility to pursue efficiency goals. Improving public sector efficiency is further complicated by an in-

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centive structure that is neutral toward or even discourages cost savings (Prager, 1994). In addition, Kelman (1990) suggests that the lack of competition, autonomous choice, profit motivation, and timely procurement source selection decisions undermine government efficiency. Values such as equitable distribution of government contracts for procured goods may also compete with efficiency goals. Finally, Meier (1987) argues that efficiency within many public organizations is not even a relevant goal and "the goal of government agencies is universal service rather than efficient service." (p. 7)

Despite the current acquisition management environment, we believe that continued improved efficiencies in system acquisition are possible. Historically, acquisition efficiency meant procuring the most goods and services for the least amount of money. However, the recent emphasis in acquisition is to find new and innovative ways to reduce costs, increase efficiency, and assess the attainment of these goals. Recent public policy trends such as privatization, competition, and process improvement may offer insight into how efficiencies can be obtained. Next we will describe these policy trends and discuss how to assess their utility for improving acquisition management.

POLICY TRENDS

PRIVATIZATION OF FUNCTIONS

Privatization is the decision to have a private sector entity perform a task currently performed by government employees (Donahue, 1989). More than 100 countries have privatized $445 billion worth of state-owned assets and enterprises in the last decade (Shoop, 1995). Privatization encompasses a range of activities including government asset sales, government service shutdowns, quasi-governmental relationships, public–private partnerships, and contracting out (Shoop, 1995). The potential for privatization is large considering the government currently performs many functions in-house that could be done by the private sector. Examples include building, vehicle, and aircraft maintenance; payroll; financial management; medical care; fire fighting; and security.

Recent examples of privatization range from employee word processing training to management of nuclear weapons facilities and base operations (Hudson, 1995). A recent report by DoD's Commission on Roles and Missions of the Armed Forces (CORM) suggests a greater reliance on the private sector and more privatization of defense support (White, 1995). Acquisition program managers must now ask if the acquisition function itself is vulnerable to privatization. Recent acquisition policy advances such as Defense Acquisition Workforce Improvement Act of 1991 have made the field more specialized. This law designates acquisition positions, an acquisition corps, and identifies qualifications for acquisition program managers in a three-level system. These efforts are designed to differentiate acquisition personnel as well as improve their performance. Potentially, these initiatives could help determine which functions or levels of responsibility are suitable for privatization. Although a threat to acquisition management positions, privatization can also present opportunities, such as widening the range of strategy options that affect military systems acquisition and their life-cycle (O&M) costs.

Competition Between Government or Civilian Contractors

In terms of fiscal policy, allowing competition between the government and the private sector represents an alternative less severe than complete privatization of the public entity. Supporters of public–private competition argue that it forces public organizations to become more efficient by reducing unnecessary costs. In addition, it can encourage innovation on both sides and also push suppliers to improve the quality of their services. However, disparities in current accounting methods and rules between the two sectors make evaluating costs challenging. These inherent difficulties in public and private-sector competition are key barriers to effective implementation. While shrinking government is relying more on private-sector contractors, the process used to compete for goods and services remains bureaucratic and risk adverse (Corbin, 1995).

"While shrinking government is relying more on private-sector contractors, the process used to compete for goods and services remains bureaucratic and risk adverse."

The formal policy facilitating competition is contained in OMB Circular A-76, "Commercial Practices and Competition." This policy establishes guidelines and procedures for the competition of functions between the government and the private sector. Although this program is more than 30 years old, private contractors have only recently been permitted to compete for many DoD functions.

The depot-level maintenance of military equipment is one area where competition has gained considerable attention and media coverage. A recent Congressional Budget Office study (1995) questions whether the public and private sectors traditional depot-level maintenance roles remain appropriate in today's environment. Currently, the private sector performs about 32% of DoD's total depot-level maintenance. The total depot work being done by the private sector ranges from 3% of Navy submarines to 100% of Army aircraft maintenance (CBO, 1995). In addition, there are many mixed modes of operation possessing both public and private sector characteristics. One example is government-owned and contractor-operated (GOCO) plants or facilities. Consequently, the extent of private sector involvement is sometimes difficult to determine.

Process Improvement

Improvement of processes is another way for acquisition program managers to increase efficiency. Historically, public fiscal activities have focused on expenditures and zeroing out the program's budget rather than reducing costs (Gansler, 1980). As Donahue (1989) argues, cumbersome rules and procedures associated with public procurement contribute to acquisition's inherent lack of efficiency. Recently, however, the Secretary of Defense authorized widespread waiver authority on policies and regulations to mitigate many of these traditional obstacles to process improvement (Perry, 1994). With restrictions removed, acquisition program managers have increased flexibility to implement

processes improving efficiency. Two popular process improvement techniques that may help the acquisition program manager are business process reengineering (BPR) and improved costing methods.

DoD is embracing business process reengineering/improvement (BPR/I) as a key element in its effort to enhance efficiency. Hammer and Champy (1993) define reengineering processes as the fundamental rethinking and radical redesign of business processes to bring dramatic improvements in performance. The Comptroller General of the United States, Charles A. Bowsher, states, "reengineering and modern technology offer huge opportunities to reduce federal costs while also improving the quality of government service" (GAO/T-OCG-95-2, 1995, p. 1) and "we support these [reengineering] efforts and will continue to evaluate DoD's progress in fundamentally improving its business processes" (GAO/T-AIMD-95-143, 1995, pp. 11–12). Acquisition management examples include a recent National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory (JPL) space mission planning BPR effort that took a string of 25–30 functional activities and clarified them as three major processes. JPL thus refocused themselves as a mission-driven organization with much more insight into costs (Beyond the Bottom Line, 1995). At the MILSATCOM System Program Office at Los Angeles Air Force Base, management redesigned many of its processes around the adoption of innovative office technologies such as electronic transfer of data and video teleconferencing (Kiatowski, 1994).

Assessment of Policy Alternatives

Which of these policies—privatization, competition between government and private contractors, and process improvement—may benefit the acquisition program manager? Several ways to assess these policy options exist.

There are many reasons why DoD had not earlier considered policy options using the private sector. One is the lack of internal transfer prices for government goods and services. Evaluating whether to build in-house or contract out is difficult without credible and relevant costs from which to determine an in-house cost basis. Further, if bids do not contain the same cost elements or use the same rules to develop those costs (e.g., depreciation), they cannot easily be compared. Finally, a relevant unit cost comparison was often impossible. In an effort to balance the playing field, DoD distributes a Cost Comparability Handbook" spelling out adjustments needed to render its cost comparable to private firms (CBO Report, 1995). OMB Circular A-76 studies also have similar leveling factors and considerations.

"Evaluating whether to build "in-house" or contract out is difficult without credible and relevant costs from which to determine an in-house cost basis."

Private sector entities rely on transfer pricing as a basis to determine internal prices and costs. In the public sector, a revolving fund can facilitate transfer pricing. A revolving fund is a financial tool used to transfer charges between public organizations. Currently, DoD uses the Defense Business Operations Fund

(DBOF) as its revolving fund. Formed by the 1991 Defense Authorization Bill, it merged DoD's Stock and Industrial Funds into one giant fund (The Pentagon, 1993a). As of 1994, the DBOF contains $85 billion, allowing certain organizations to transfer the charges for products between them (DoD Comptroller, 1994). The cost of non-value-added activities can also be recognized because visible prices are attached to those activities or processes and one can derive relevant unit costs.

As currently employed, the DBOF has some restrictions that interfere with the establishment of true marketlike incentives. One limitation is the use of legislatively established rates, rather than market prices or unit cost, to determine transfer prices (OPM, 1987; The Pentagon, 1993b). Legislative controls on prices and lack of profit incentives impede the efficient allocation of resources within public organizations and prevent true competition. If a public organization were allowed to make, retain, spend, and distribute profit, its management would have the incentive to improve its organizational efficiency. With practices now being employed by DBOF, the acquisition manager can credibly assess programmatic decisions using private sector practices like financial analysis and activity-based costing (ABC).

Financial Analysis

The use of traditional private sector financial analysis to compare public and private sector operations is one means to evaluate the use of different policy options. If financial analysis suggests a public entity performs much less efficiently than a comparable private sector business, then privatization, competition, or process improvement options can be considered. In the past, traditional financial analyses have not been generally performed on public functions because of the lack of relevant data. Recent legislation now has made possible the financial comparisons of public and private sector functions. For example, using financial data directed by the CFO Act, several financial ratios can be computed. While the comparisons might not be completely valid, the realization that common-size assessments are possible is a significant development useful to acquisition program managers.

Financial ratio analysis is a private sector technique used to compare the operations of firms. This technique facilitates the analysis of differently sized organizations within the same line of business. The use of ratio measures such as liquidity, asset management, and profitability are appropriate for this type of assessment (Harrison & Horngren, 1992). For example, by examining asset management measures such as turnover (i.e., how well an entity uses its resources to generate sales) or inventory turnover (i.e., how fast the entity turns over its inventory), efficiency comparisons can be made. By evaluating basic financial ratios, an acquisition program manager can assess whether the decision to privatize, compete, or improve a function or process has merit. A recent example is the analysis of retailing operations of the Army and Air Force Exchange Service (AAFES). By comparing the operating performance of other large retailers such as Wal-Mart, one can determine what needs improvement. Some comparisons may show that the private sector can do a better job and should be allowed to do so.

Although the emergence of relevant accounting data has potential benefits in decision making, privatizing decisions remain complex. Privatization often may mean certain government facilities get less use. Local constituents may object to the closing or reduction of government facilities, believing that their local economy will suffer lost jobs and lower tax revenue. However, those losses are often offset by new contractor jobs. The ongoing debate on how to operate depot-level maintenance is testimony to this phenomenon (CBO, 1995). Perhaps the most significant consideration is whether some functions should be exempt from privatization because of combat capability concerns, national security, and other potential conflicts of interest.

Financial analysis can also help the acquisition program manager improve processes and become more efficient. With the advent of such legislation as the CFO Act and the existence of DBOF operations, for the first time data may be available that will allow program managers to use private sector efficiency metrics. Also, financial analysis using concepts such as operating leverage may illustrate which acquisition management approach is the most cost efficient and whether privatization or competition of certain functions is appropriate (Ciccotello & Green, 1995).

Activity-Based Costing

Privatization, competition, and process improvement are facilitated by the growing use of ABC methods in the accounting community. These methods tie the total costs of production or services more closely to the activities driving the costs (Johnson & Kaplan, 1991). Before DBOF and ABC, the costs of many requested goods and services were "hidden" to managers. With unit costs visible and relevant, managers may decide whether a product is really needed. If costs are too high, the commander or acquisition program manager can shop elsewhere for the product or do without. In a related study, Eldenburg (1994) concludes that making costs visible to physicians actually reduces health care costs.

"With visible and relevant unit costs in front of them, managers may decide whether a product is really needed."

Implementing process improvement involves the adoption of advanced costing methods. Acquisition program managers can learn by studying recent developments in the private sector accounting community. Knowledge of relevant total costs and their effect on unit costs, as revealed through modern management information systems and innovative accounting practices, may help managers become more efficient by improving the tracking accuracy of the true cost of producing output (Stevenson & Barnes, 1993). With accurate information about unit of production or activity costs and the identification of cost drivers, acquisition program managers can re-evaluate their acquisition strategies. Cost knowledge allows them to discern value-added activities from non-value-added activities. By eliminating the latter, total costs can decrease. A decrease in total costs helps an organization become more efficient and allows the cost savings to be used elsewhere. Having an idea of a true unit cost may mean the survival of a program. An

example might be the increasing congressional concern about the cost of one cadet (unit) at the Air Force Academy as compared with other commission sources or the extremely large cost now attached to a single (unit) B-2 Bomber (McMillin, 1990).

INCENTIVES

Some would argue that without motivation, workers have little incentive to become efficient. In many cases, perverse incentives may encourage inefficiency—for example, an effort to secure bigger budgets for non-value-added activities. Incentives for efficiency may come from the threat of having functions privatized or be derived from rewards for improvements in performance. While possible incentive programs for acquisition program managers would be a function of size, service, and system, the knowledge that private sector acquisition program managers may be easier to motivate might be a key factor to consider. In fact, some argue that the current basic approach to buying major weapon systems, with a government program office mirroring a contractor program office, is a wasteful duplication of effort. Perhaps only one organization is needed and it may indeed be the contractors. This approach to process improvement would result in privatization.

"Incentives for efficiency may come from the threat of having functions privatized or be derived from rewards for improvements in performance."

For acquisition program managers, competition traditionally means more choices. It may also mean increased efficiency. If government and private contractor facilities are bidding for production work, the competition could lower acquisition costs. To the extent that this minimizes the market power "sole source" contractors now possess, the result will be reduced acquisition costs. More choices for out-year maintenance work could also reduce life-cycle cost estimates, which would make a program more appealing to DoD decision makers. Also, top-level acquisition managers must relinquish some direct financial control to push decision-making down to lower levels. For example, acquisition program managers could be given the power to make procurement decisions and be held accountable for financial performance. Such flexibility could change how program offices are staffed and how acquisition contracts are designed. Acquisition program managers could decide, for example, to privatize staff functions typically done in-house. In sum, the result of enhanced program manager power would be the use of more innovative acquisition strategies. Whether this change ultimately benefited the government would be an empirical issue worthy of examination.

CONCLUSION

Three policy initiatives are sweeping public sector management: privatization, competition between the public and private sector, and process improvement. We believe that acquisition program managers must not only be aware of these trends, they must implement policies to improve

efficiency or face the threat of privatization themselves. Private sector assessment metrics and cost development approaches such as financial analysis and ABC, are a means of comparing the operations of public and private entities. We argue that privatization, competition between government entities and civilian contractors, and process improvement all represent current trends in DoD management community that should interest acquisition program managers. As current federal financial management reform efforts continue, the acquisition program manager should proactively investigate and implement them. If they do not embrace this change, acquisition as we know it surely will not survive into the twenty-first century.

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ADDRESSING RISK MANAGEMENT IN NON-DEVELOPMENTAL ITEMS ACQUISITION PROGRAMS

Michael R. Steves

Non-developmental Items (NDI) acquisition programs are enjoying popular support as faster, cheaper alternatives to new start research and development programs. Unfortunately, DoD policy on risk management in NDI programs is lacking. In the new, less-restrictive DoD Directive 5000.1 Acquisition Policy and DoD Regulation 5000.2-R, the program manager (PM) is expected to tailor risk management practices to the needs of the program. Tailoring DoD risk management policy to support NDI program management leaves the PM too much guesswork. An NDI PM's risk management program cannot reasonably benefit from DoD risk management guidance, procedures, and tools because he or she is focused on new development program risks and risk management practices. Missing is any explicit consideration of unique NDI risks and risk management requirements. NDI PMs need more structured policy and instruction regarding NDI risk management for the streamlined, accelerated NDI acquisition environment. A lesson that we have learned is that we need a published risk management plan as the source of NDI risk management program decisions and actions. This article makes specific recommendations for including NDI risk management in DoD policy.

Today's era of defense downsizing has the military services scrambling to protect research, development, and acquisition (RD&A) funds and to preserve their acquisition programs. Quality of life issues, training and readiness, and peacekeeping missions continue to draw funds away from RD&A programs and modernization. The armed services and their acquisition program managers are challenged to justify lengthy and costly new research and development programs when commercial or nondevelopmental solutions exist. Risky acquisition strategies and mistakes in new research and development acquisitions have become harder to defend. A new program's risks will demand close management to prevent unanticipated or poorly planned-for events from exposing the program to funding cuts or cancellation.

To the rescue, or so many expect, comes the Non-developmental Item (NDI). NDI system acquisitions give PMs and the gov-

ernment rapid, lower cost access to advanced technology. NDI acquisition strategies offer the promise of risk mitigation and a lower risk means of meeting the armed services' urgent mission needs and operational requirements. NDI program management is not, however, without risk. An NDI program manager must tailor the program's risk management to the unique risks and uncertainties in NDI system acquisitions.[1] NDI risk management demands more than tailoring. Problems arise with NDI risk management because NDI risks and necessary risk management processes are not well understood or described in Department of Defense (DoD) policy. NDI risk management demands policy, framework, and tools to assist the PM. An NDI acquisition's purpose is to simplify and accelerate the acquisition process to meet the program's, and ultimately, our soldier's needs. Successful NDI acquisition programs would benefit from a more clearly mapped risk management policy structure, rather than broad expectations of tailoring, to fulfill their promise of simple, rapid, and reduced-risk acquisitions. The simple, fast, cheaper route to NDI risk management success requires good directions and signposts advising PMs of risks and precautionary measures.

Risk Management and Non-Developmental Item Overview

DoD's risk management concepts are consistent with those in industry. DoD guides on risk management are similar to the Program Management Institute's (PMI) body of knowledge on risk management. The PMI approach reflects the general body of knowledge on risk and risk management that may be found in business and industry today.

Risk Definition

Webster's 3d International Dictionary defines risk as "the possibility of loss, injury, disadvantage, or destruction; someone or something that creates or suggests a hazard or adverse chance; the product of the amount that may be lost and that probability of losing it (p. 1961). DoD Directive (DoDD) 5000.1 and DoD Regulation (DoDR) 5000.2-R do not define risk to coincide with discussions of risk management or risk reduction. Risk is often characterized by type: cost, schedule, technical performance, supportability, and programmatic risk (DSMC, 1989).

These five types of risk interact to affect a program's overall performance.

[1] Tailoring is a practice that means modifying the acquisition process to reduce the time required to meet user (soldier) needs. Tailoring is expected to be done according to common sense, effective business practice, laws, regulations, and a program's anticipated fielding date (DoD Directive 5000.1, 1996). The concept of tailoring risk management is considered valuable by DoD as part of the program manager's authority.

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Their basis is in the five-phase, four-milestone, full-scale development acquisition cycle found in the now-rescinded DoD Instruction 5000.2.

Risk Management

The DoDD 5000.1 (1996, p.4) defines risk management as an approach that "encompasses risk identification, mitigation, and continuous tracking, and control procedures that feed back through the program assessment process to decision authorities." This definition differs from the business definition in that it stresses a systematic approach rather than "art and science." Risk management identifies and evaluates the program areas vulnerable to high levels of uncertainty. Its purpose is to provide a means of comparing risk management performance to a standard and of tracking risk-related information. By doing so, DoDR 5000.2-R adds that risk management becomes an essential element of a program's acquisition strategy (1996, Part 3, p. 3).

The Defense Risk Management Process

A PM's risk management process should set objectives and continually assess the program for obstacles that hinder accomplishment of those objectives. It allows the PM to formulate alternative courses of action and to make rational decisions on monitoring and controlling the outcomes or consequences of program events.

Upon identification of a program's risks, a four-part process begins. The four defense risk management process components are planning, assessment, analysis, and handling. Once these components are implemented, the risk mitigation effort is underway. Risk mitigation is the combination of risk handling and risk controls. DoDD 5000.1 notes that technology demonstrations, prototyping, and test and evaluation are the available techniques to assess and handle risk. The PM should document the risk management program, process, and techniques. Publication of a risk management plan (RMP) is one means of accomplishing this.

Non-Developmental Items

An NDI is a previously developed federal, state, local, or foreign government item with little or no development effort required (5000.2-R, Part 3, p.5). NDI acquisition strategies look to governments or commercial vendors as sources for a developed and available item. DoDD 5000.1 encourages the armed services to use the most cost-effective materiel solution over a system's life cycle. The first choice among materiel alternatives after buying commercial off-the-shelf items is to procure or modify previously developed U.S. military or Allied systems or equipment (p. 6).

The armed services in the past have defined NDIs more specifically.[2] The Army

[2] Confusion sometimes results from the attempt to distinguish an NDI from a commercial off-the-shelf (COTS) item. A COTS item does not make up a portion of NDIs. COTS items are commercial hardware or software items not yet modified by the government, items that are in the commercial inventory or production, that have proven their performance in a similar environment, that have an existing support structure, have an internal support structure, have an internal configuration that flows with commercial changes, and generally are integrated with other hardware and software items to become part of a system or subsystem capability. An NDI therefore might be described as a noncommercial off-the-shelf item.

version distinguishes NDI in three categories (Quindlen, 1989):

1. Category A (basic NDI). No modifications are required.

2. Category B (NDI adaptation). This category is sometimes referred to as "Ruggedized NDI."

3. Category C (NDI integration). This category is sometimes referred to as "Militarized NDI."

Advantages and Disadvantages of NDIs

NDIs are considered a means of mitigating program cost and schedule risks. Risk mitigation can be implemented in a shortened or streamlined Program Definition and Risk Reduction Phase and Engineering and Manufacturing Development (EMD) Phase of the acquisition process. The advantages of NDIs, according to the Government Accounting Office (GAO), include shorter acquisition time, reduced cost, proven technical performance or mature technologies, and simplified contracting procedures involved in procuring established products. Yet NDI acquisitions do not eliminate risk they may actually introduce new, significant risks. These risks will be examined shortly.

An effective NDI acquisition program must fulfill the service's needs by fielding mature technology that contributes to combat readiness while satisfying the user's expectations. The three features that attract substantial DoD and Congressional support for NDI or commercial alternatives but challenge the PM are:

1. Meeting user requirements based on available government or commercial market solutions.

2. Preparing minimum but not objective ("gold-plated") user requirements to support lower program costs and rapid system fielding.

3. Providing DoD with greater access to state-of-the-art technology to keep pace with changing threats, emerging technologies, and innovative combat systems.

The danger to NDI programs and their effective risk management is in forcing NDI solutions on PMs and their customers (the user community), when those NDIs neither meet requirements nor transition effectively make the transition from current government or commercial applications to battlefield environments. Broadly stated DoD risk management policy and guidelines then contribute to disadvantages as well as advantages of buying NDIs.

The disadvantages of NDIs and NDI acquisition strategies stem from the new start research and development program paradigms in the acquisition community. A developmental item PM traditionally faces cost, schedule, performance, supportability, and programmatic risks; NDI program risks are often unique. In reviewing the literature, I have found that the following areas make up the most pressing potential risks facing NDI program objectives: a) requirements, b) NDI acquisition management environment, c) performance specifications and nongovernment standards (S&S), d) test and evaluation (T&E), and e) integrated logistics support (ILS).

The NDI PM's principal disadvantage is a lack of both DoD policy attention paid to the above NDI program risks and the

procedures and tools to manage them. This void in NDI-specific risk management guidance leaves the PM without current references for structuring a risk management program or publishing an RMP. Meanwhile, the pressure to use NDI solutions at the expense of a service's original needs and requirements may yield fielded items that aren't compatible or interoperable with the intended operational environment or battlefield systems.

The Divergent Paths

The crux of the NDI risk management issue is that the paths of risk management policy and NDI policy do not cross. DoD policy emphasizes both risk management and NDI but in differing directions. Risk management policy in the DoD 5000 series keys on developmental items and acquisition strategies. This is demonstrated in the traditional cost, schedule, and performance risk orientation of current policy. NDI policy focuses on risk mitigation gained through use of established government sources of supply. Cost and schedule benefits aside, no description or instruction for NDI program risk management appears in the DoD 5000 series. The 5000.1 and 5000.2-R policy voids exist within the expectation that the program manager will "tailor" (overlap, combine, or omit) risk management requirements to an NDI acquisition strategy.

NDI acquisitions streamline acquisition policy and particularly, risk management policy, and result in tradeoffs between program objectives. While NDI programs may mitigate risks in cost and schedule, technical performance, supportability, and programmatic risks may be heightened by the NDI-specific risks listed earlier. The consequences of NDI-specific risk events in these areas can have tremendous affect on cost and schedule in the long run.

NDI PMs currently conduct risk identification, planning, analysis, assessment, handling, and documentation according to the 5000.1 and 5000.2-R. In doing so, the PM applies *developmental* acquisition risk management policy and procedures focusing on traditional developmental program risks to *nondevelopmental* systems. The point is that many NDI acquisition PMs must "think on the move" without explicit directions or road maps. Without DoD or service-specific NDI risk management policy, instructions, templates, or unofficial emphasis in Defense Systems Management College (DSMC) risk management publications or instruction, PMs will continue to rely on gut feelings, developmental lessons learned, and incomplete references. NDI risk management planning can be second-guessed since no official references can be cited to justify risk management decisions. Lack of published DoD RMP formats increases this risk.

"The crux of the NDI risk management issue is that the paths of risk management policy and NDI policy do not cross."

There are reasons for this policy void. The risks in NDI acquisition are not as widely described or documented as the benefits. The absence of documentation and description is due to lack of familiarity by PMs, users, and DoD overall with the NDI acquisition risks in competitive, commercial (defense- and nondefense-related) industries. These industry sources provide DoD with a growing number of

NDI systems not initially developed to meet a specified armed service requirement. The defense acquisition community's unfamiliarity with NDI risks and risk management means a lack of understanding with commercial risk management practices and standards. Without formal risk management policy and guideline initiatives by DoD acquisition participants, definitive policy and instruction has insufficient support or momentum to be officially implemented.

Merging the Two Paths

The challenge of DoD is to bridge the gap between developmental acquisition risk management policy and practices and those that apply specifically to NDI risks. Effective application of NDI-based risk management policy and practice can save NDI and possibly COTS PMs valuable time, money, and manpower resources while assisting them in effectively meeting program goals and objectives.

Proposed DoD Policy Revisions

DoDD 5000.1 Risk Management Policy. DoDD 5000.1 contains five areas which could be revised to make its risk management guidance suitable for NDI PMs. The first area is the risk management subsection of Part 1 (p. 4). It presently states:

> [Program mangers] and other acquisition managers shall continually assess program risks. Risks must be well understood, and risk management approaches developed, before decision authorities can authorize a program to proceed into the next phase of the acquisition process. Risk management encompasses identification, mitigation and continuous tracking, and control procedures that feed back through the program assessment process to decision authorities.

This guidance lacks reference to a definitive risk management planning structure. Currently, NDI PMs are expected to tailor the DoDD 5000.1 risk management guidance to their NDI systems acquisitions. The following could be added for more structural content to both NDI and developmental risk management planning:

> Each milestone decision point will include a review of the updated risk management plan (RMP) and measures taken to identify, assess, analyze, handle, and document program risks. Continuity will be maintained between the RMP and discussions of program risks in the Integrated Program Summary, Acquisition Plan, Systems Engineering Master Plan, Test and Evaluation Master Plan, and Integrated Logistics Support Plan.

The RMP could be modeled after DSMC Risk Management or DSMC *Systems Engineering Management Guides'* RMP formats and tailored to the requirements of the individual program. It would require the "teaming" of the user and the PM to integrate a risk management focus that supports operational need and requirements development. It could then be monitored through the Integrated Product Team Process.

The second area is the Event-Oriented Management subsection of Part 2 (p. 6),

which describes "a rigorous, event-oriented management process that emphasizes effective acquisition planning, improved and continuous communications with users, and prudent risk management by both the government and industry." This statement overlooks risk areas, especially those in NDI programs: requirements, NDI acquisition management, T&E, S&S, and ILS.

The DoD 4245.7-M, published in 1985, described the areas of risk that jeopardize achievement of successful cost, schedule, and performance objectives. It did not describe NDI risks acting as cost, schedule, or performance drivers. The Hierarchy of Materiel Alternatives subsection immediately following Event-Oriented Management currently doesn't refer to them either. Event-oriented managers are empowered with the authority to make trade offs between performance and schedule for the sake of cost objectives. The authority to trade off performance or schedule to control program cost risks can imply the acceptance of force readiness and doctrinal capability gaps. If no operationally effective replacement systems exist, then such trade offs can have significant impact on force training and combat effectiveness.

The following could be added to reflect NDI risks:

> NDI programs shall examine and track the effects of requirements, NDI acquisition management, Test and Evaluation, Specifications and Standards, and Integrated Logistics Support risks on cost, schedule, and performance objectives. Measures of performance for risk handling shall be proposed in the RMP concerning these risks. Trade-offs shall be considered primarily when current systems exist to sustain the force until the NDI system is fielded.

The third area of interest is a combined look at the Test and Evaluation and Modeling and Simulation subsections in Part 2 (p. 6). The Risk Assessment and Management subsection refers to test and evaluation. Integrated testing and evaluation, including modeling and simulation, is used to identify areas of technical risk, to "assess attainment of technical performance parameters... to reduce the time, resources, and risks of the acquisition process" (p. 6). The Risk Assessment and Management subsection itself reads: "To assess and manage risk, [program managers] and other acquisition managers shall use a variety of techniques, including technology demonstrations, prototyping, and test and evaluation.

"The risks in NDI acquisitions are testing too little, too much, and testing to the wrong or modified requirements using contractor test and evaluation inputs."

NDI acquisition strategies often include accelerated and streamlined (depending on the quantity and quality of contractor test programs and data) testing and evaluation processes or simply contractor test and evaluation data reviews. The risks in NDI acquisitions are testing too little, too much, and testing to the wrong or modified requirements using contractor test and evaluation inputs. The following could be included to address these concerns:

> NDI market analysis of proposed designs, NDI test and evaluation pro-

grams, and NDI performance specifications shall carefully consider trade offs in test and evaluation for the sake of short-term cost and schedule objectives. Such trade offs introduce risks to NDI life-cycle costs and support. NDI contractors' test and evaluation data shall be screened and validated independently by the operational test and evaluation community.

The fourth area considers contractor responsibilities again from the Risk Assessment and Management subsection. Previously, solicitation documents required contractors to identify risks and specify plans to assess and eliminate risks or reduce them to acceptable levels. Now, DoDD 5000.1 directs that (p. 4) "To ensure an equitable and sensible allocation of risk between government and industry, [program mangers] and other acquisition managers shall develop a contracting approach appropriate to the type of system being acquired."

The shortfall in this guidance on contractor risk management is the lack of parallelism between the NDI PM's RMP and requirements and those of the contractor. The NDI risk management efforts should emphasize teaming and risk-sharing to relieve the burden of risk management from resting primarily on the government. This is particularly true with the accelerated nature of NDI acquisitions. Risk responsibility in NDI programs should rest in large part with the contractor, given the supposedly mature system being offered. The following could be added: "Contractor RMPs shall be specified in solicitations as a deliverable. These shall be consistent with DoD program managers' RMPs. Risk sharing shall be emphasized in contracts and monitored by the DoD–contractor team through integrated product teams (IPTs).

"The NDI risk management efforts should emphasize teaming and risk-sharing to relieve the burden of risk managment from resting primarily on the government."

The fifth area combines its focus on the Tailoring, IPT, and Management Control subsections in Part 2 (p. 8). The guidance makes no mention of NDI risks even as materiel alternatives are repeatedly called for prior to beginning a new major defense acquisition program. Risk plans, assessments, and controls, which are subject to tailoring, should be comprehensive in nature and include the full spectrum of risks expected for a NDI program. Tailoring, IPTs, and management control could address the five NDI-specific risk areas by directing that an RMP be prepared and reviewed at each milestone.

The DoDD 5000.1 risk management policy revisions are an important first step. Policy must clearly state the risk management requirements and guidelines as they specifically affect a NDI PM's risk management program. These changes will provide impetus for revisions to DoDR 5000.2-R, which will be examined next.

DoDR 5000.2-R Risk Management Policy and Procedures. The NDI program managers need more definitive and explicit policy and procedures in DoDR 5000.2-R pertaining to their risk management programs. The 5000.2-R, even with its increased commercial and nondevelopmental item emphasis, neglects NDI risk

management. With increasing competition for shrinking DoD RD&A budgets and resources, DoD and Congressional risk tolerance will decline, pressure will intensify to manage programs according to sound business practices, and "safer" acquisitions will attract more support. *In these circumstances, explicit NDI risk management instruction will become critical to NDI program management.*

Two parts of DoDR 5000.2-R could better serve NDI PMs with more explicit discussion of NDI risks and risk management implementation procedures. The first is Part 3. The regulation encourages acquisition program stakeholders to examine the full range of mature or developing materiel alternatives before initiating a new program. Emphasis is placed on cost, schedule, performance, interoperability, trade offs, and risk management. The use of IPTs and tailoring are introduced as additional major program considerations for each milestone decision point. A program's decision authority, documentation, and milestone reviews will be subject to the program size, complexity, and risk, as well as the flexibility intended through IPTs and tailoring.

As part of the original DoD Instruction 5000.2, risk assessment formats were provided in the now-rescinded DoD 5000.2-M. The format description did more to encourage tailoring than to depict a specific risk assessment format; it provided little to support outlining an NDI risk assessment, much less an RMP. The current 5000.2-R provides no formats. PMs are given wider latitude to prepare their own risk assessments and risk management plans and programs. Any current format would be helpful if it were to refer to the the old DoD 4245.7-M risk areas. Additionally, with NDI and streamlining initiatives more common today, *more* detail is required than currently described or provided in those sets of templates in the supportability and programmatic sources of risk as well as the NDI-specific Requirements, S&S, T&E, ILS, and NDI program management environment risk areas.

In the 5000.2-R, milestone 0 concentrates on materiel alternatives to a new major defense acquisiton program. The milestone I, II, and III reviews, however, repeatedly focus on acquisition program baselines (APB), acquisition strategies, and exit criteria. The APB content, especially pertaining to cost, is subject to refinement during each program phase. A refined APB encourages risk reduction efforts. Risk reduction efforts are based on careful risk assessments, which are a basis for overall cost parameters and realistic cost estimates. But no format is provided in the regulation. No tie-in is made to NDI APBs or NDI risk assessments and unique risk reduction requirements. Program acquisition strategies each have risk management as an essential element. Again, while NDI programs will have their own acquisition strategies and risk management programs, no format or tools are offered. The exit criteria or "gates" that the system must pass to meet program goals and enter a new acquisition phase are selected to track progress in important technical, schedule, or management risk areas. No explicit mention is made of NDI, Requirements, S&S,

"The targeted risks are technical, manufacturing, and support risks that must be controlled before the next milestone decision point."

T&E, ILS, and NDI program management risk areas, or their influence on exit criteria.

The second part of DoDR 5000.2-R procedures concerns Part 1. The milestone decision point reviews discussed in DoDR 5000.2-R do not cite one central document as the reference for a program's risk data or the planned risk management program. Part 1 points to Phase I, Program Definition and Risk Reduction, as the period when prototyping, technical demonstrations, and early operational assessments are used to assess and reduce risk. The targeted risks are technical, manufacturing, and support risks that must be controlled before the next milestone decison point. The regulation implies that these risk reduction techniques are done primarily in Phase I. In addition to emphasizing risk management as a program function done *throughout* the acquisition life cycle, reference should be made to an RMP as the source of documented program risks, risk assessments and analysis, risk reduction measures, rationale, and assumptions in published risk ratings. This could be more effective than flipping between the Integrated Program Summary, Acquisition Plan, T&E Master Plan, and Systems Engineering Master Plan.

The regulation policy should explicitly cite the NDI streamlined acquisition cycle, and the parts of DoDR 5000.2-R in which detailed descriptions of NDI risks and risk management actions appear. For example, part 3.3.2 of the 5000.2-R could feature the NDI requirements, test and evaluation, integrated logistics support, performance specifications and commercial standards, and NDI acquisition management risks. Risks, possible risk ratings and assessment considerations, and initial risk handling options could be listed as program deliverables at milestone reviews. NDI risks and risk management could then be distinguished from the developmental features in the DoDR 5000.2-R.

Risk Management Templates. Below are areas for consideration using DoD's former DoD 4245.7-M risk management tool, the risk template. This would clarify DoD's position on NDI risks and provide recommended risk management measures to the benefit of NDI PMs, their programs, and their customers.

Requirements Risk Template
Areas of Risk:

1. Operational and design requirements that are ill-defined or overlook NDI alternatives.

2. Inadequate market analysis that contributes to "mix and match technologies" being required rather than verification of what technology actually exists.

3. Trade offs in threshold and objective performance requirements that fail to meet the user's stated need. Improperly defining the proposed system's prospective sources (commercial, modified commercial, or NDI) and required future design modifications.

Outline for Reducing Risk:

1. Insert NDI market analysis into the acquisition cycle as part of Phase 0, Concept Exploration and Development.

2. Use the IPT structure to better screen and develop requirements.

Timeline: All phases.

Performance Specifications and Non-government Standards Risk Template
Areas of Risk:

1. Technical performance in commercial applications as specified in commercial item descriptions (CIDs) may not equate to or explicitly meet technical performance in military applications as stated in MIL-SPECS and MIL-STDS after an NDI acquisition strategy is already approved.

2. Performance specifications and standards based on form, fit, and function (that allow contractors to design solutions) instead of the "how-to" MIL-SPECS and MIL-STDS used in design and manufacturing may encounter workforce resistance or complacency.

3. Inadequate market analysis leads to acceptance of products having insufficient or undocumented technical data or CIDs with which to recompete the procurement for future buys.

Note: The DoDR 5000.2-R states that the PM "shall structure the acquisition strategy to promote sufficient program stability to encourage industry to invest, plan, and bear risks ... program acquisition strategies must analyze industrial capability to design, develop, produce, support, and restart a program... analysis will identify DoD investments needed to create any new industrial capabilities and the risk of industry not providing the manufacturing capabilities at the planned cost and schedule" (Part 3, p. 5).

Outline for Reducing Risks:

1. Specify in solicitations that CIDs for meeting user requirements are a deliverable.

2. Evaluate the CIDs against MIL-SPECS to verify their adequacy for design and development.

3. Train and educate the acquisition workforce in CIDs and commercial specifications.

Timeline: All phases.

NDI Acquisition Management Risk Template
Areas of Risk:

1. Despite streamlining, paperwork requirements, pricing data, accounting requirements, and continuous audits of NDI programs stifle the cost and schedule objectives laid out in the acquisition strategy.

2. Traditional developmental program paradigms and developmental program mindsets continue to reflect a cultural resistance toward implementing timely and cost-effective NDI acquisition strategies.

3. Lack of PM-contractor and PM-user teaming on risk responsibility and

risk sharing hampers flexibility in risk management efforts.

4. Programmatic micro-management by stakeholders defeats the benefits of an NDI acquisition strategy.

Note: DoDR 5000.2-R discusses cost management incentives, stating "risk reduction through the use of mature processes shall be a significant factor in source selection (Part 3, p.7) ... and "the acquisition strategy shall discuss types of contracts ... to include considerations of risk assessment, reasonable risk sharing by government and contractor(s)" plus the schedule risk of using government furnished equipment or government furnished information (Part 3, p. 8).

Outline for Reducing Risks:

1. Require RMPs as a contractor deliverable.

2. Require workforce training and education in NDI through DSMC.

Timeline: All phases.

Test and Evaluation Risk Template
Areas of Risk:

1. Requirements are not stable, realistic, or well-understood by designers, developers, testers, or managers.

2. Overtesting conducted despite the presence of satisfactory contractor test and evaluation data package.

3. Developmental and technical testing costs are saved but operational testing for operational effectiveness and suitability may involve conditions not grasped by contractor testing program. These incomplete tests and data may be overlooked or unquestioned in the accelerated NDI acquisition cycle and corresponding accelerated NDI testing program.

Outline for Reducing Risks:

1. Test and evaluation data reviews of contractor commercial testing program and results.

2. Demonstrations of the contractor's testing process.

3. Modeling and simulation anchored in realistic, integrated T&E with combined DT/OT, and live fire T&E. Examples are TECOM's Simulation and Modeling Anchored in Real Testing (SMART) program and Virtual Proving Ground initiatives and its Combat Synthetic Test and Training Assessment Range (STTAR) capability used at a recent National Training Center rotation by the 1st CAV Division.

Timeline: All phases.

Integrated Logistics Support Risk Template
Areas of Risk:

1. Technical data packages may be unavailable or incomplete, which creates instability of spares and parts access.

2. Competitive re-procurements of parts may not contain proper incentives to attract spares and parts vendors.

3. ILS and a system life-cycle focus may be overlooked during the requirements development stage.

4. Use of military standard and nonstandard parts creates multiple parts and spares lines.

5. Depot and repair levels may not be defined in terms of operational environments.

Outline for Reducing Risks:

1. Define ILS requirements when deciding what category of NDI the acquisition strategy involves.

2. Conduct market analysis of contractor ILS capabilities, ILS testing, and support demonstrations in the intended operational environment and conditions.[3]

3. Specify training packages and publications as a contractor deliverable.

Timeline: All phases.

These revisions provide guidance to NDI PMs. The template diagram, area of risk, risk reduction outline, and a life cycle timeline for managing these risks should be included. Clarifying risk management policy and upgrading NDI risk management templates can streamline the risk management process by saving time, manpower, and the resources required to staff a risk management program. The NDI interpretation of developmental item templates would become unnecessary.

CONCLUSIONS

The practice of risk management does not benefit from "cookbook" solutions. If such solutions existed for developmental acquisition programs, there are very few, if any, for NDI acquisition programs. This is the NDI PM's dilemma. The NDI PMs must adhere to DoDD 5000.1 and DoDR 5000.2-R risk management policies in their programs, but the material is vague or must be tailored to support NDI program needs. The situation leaves the NDI PM driving a risk management program without the benefit of signposts or road maps.

NDI PMs continuously manage risk as part of today's streamlined and tailored NDI acquisition environment. They should expect and receive succinct, explicit policy and guidelines to help them meet their risk management and program management goals and objectives. DoDD 5000.1 could better serve the NDI PMs with risk management language directed to their specific type of programs and ac-

[3] Options the program manager can consider include those posed in DSMC's NDI acquisition publication
1. Buy commercial upgrades as they evolve and become available.
2. Make a one-time mass spares purchase to sustain the duration of the system's life cycle.
3. Buy the technical data package to solicit sources of supply that coincide with the end of original production and support by the original contractor.

quisition strategies. DoDR 5000.2-R could provide NDI PMs with both better risk management guidance and implementation procedures with NDI-based instructions, formats (once found in DoD 5000.2-M), and tools (once found in DoD 4245.7-M risk templates and risk management plan).

The NDI program manager's challenges and program risks in the late 1990s are not adequately reflected in DoD's mid-1980s risk management policy, procedures, or tools. Risk management will receive more, not less, emphasis as an explicit management function. NDI and NDI acquisition strategies will continue to grow in popular support as DoD RD&A budgets are "downsized". Modernization at minimum risk, therefore, will require properly marked signposts and a good road map. It is time for DoD to print and distribute those signs and maps.

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A HOLISTIC MANAGEMENT FRAMEWORK FOR SOFTWARE ACQUISITION

Yacov Y. Haimes, Richard M. Schooff, and Clyde G. Chittister

In the face of the federal government's recent downsizing effort and the increasing pressure to reduce government expenditures and improve oversight of the use of public funds, reform of government acquisition policies and practices has been a major initiative. While software acquisition is increasingly included in the discussion of acquisition reform, the concept of software acquisition is in fact a misnomer (even though it is included in the title of this paper). Our government acquires systems, not exclusive software per se; these systems increasingly include a major software component.

Software's critical impact on system reliability and performance makes effective software acquisition policies and strategies essential. This article considers software acquisition issues being addressed in an ongoing project conducted by the Center for Risk Management of Engineering Systems at the University of Virginia, and the Software Engineering Institute, Carnegie Mellon University.

Because preventive action is the key to successful risk management, one must plan how to avoid software system risk early in the system life cycle—before the software is purchased. The federal government's expenditures for software products and services are tremendous, and government acquisition procedures, regulations, and results are readily available for public review. This article focuses on government mission-critical software acquisition, and particularly software acquisition efforts of the Department of Defense (DoD). The results of this study will be useful to other government agencies as well as to the private sector.

Effective management of modern, complex processes such as software acquisition requires capable, mature direction. Good management of technological systems must address the holistic nature of the system in terms of its hierarchical, organizational, and functional decision making structure; various time horizons; the multiple decision makers, stakeholders, and users of the system; and the host of technical, institutional, legal, and other socioeconomic conditions that require consideration. Good management also implies the ability to identify program risks, evaluate their potential adverse impact, and effectively incorporate risk con-

siderations in the decision making management framework.

The fundamental goal of this article is to describe the development of a quantitative risk management framework for software acquisition, centered on hierarchical holographic modeling (HHM) (Haimes, 1981). This management framework can then be generalized for application to other emerging large-scale systems and processes.

Here we build on current knowledge and experience in software acquisition, software engineering, management, and decision making, and in risk analysis, and incorporate this knowledge with the principles that guide systems engineering. The proposed holistic vision of the software acquisition process and the proposed methodological framework for the management of this process are ultimately aimed at controlling the risk of projects' cost overruns and completion schedule delays. For a discussion of managing software technical risk, see Chittister and Haimes (1994a).

THE APPROACH

Recognizing that software is only one component of a larger system (and that software is, itself, a system made up of multiple components, elements, and entities), one must manage software acquisition by considering the larger picture and take a systemic approach to resolving the complex interconnections of the multiple participants, activities, events, risks, and other process elements. With the ever-increasing importance and complexity of the software component of modern systems, it is essential that software acquisition be addressed in terms of its overall system.

We will not explicitly address the multiple aspects associated with the software acquisition process. Our objective is instead to develop a modeling framework that will enable the consideration of such complexities and interconnectedness, and then outline the approach as it applies to particular subcomponents of software acquisition: the *process* vision, composed of its multiple stages of activities; the *pro-*

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gram consequence vision, which includes technical performance, cost, and schedule; and the *community maturity* vision, which includes user, customer, contractor, and technology.

This work draws on a holistic representation of such complex systems and processes termed hierarchical holographic modeling (HHM). Fundamentally, HHM is grounded on the premise that complex systems and processes, such as the software acquisition process, should be studied using more than one single model, view, or perspective. HHM possesses a dual nature: it is holistic, investigative paradigm, and a mathematically sound, hierarchical, multiple-objective decision making methodology. Exploiting the inherent synergy of HHM's duality provides the necessary theoretical, methodological, and practical foundation for a risk assessment and management framework for the software acquisition (and other large-scale) process. The approach of this work (see Figure 1) is to represent software acquisition by an HHM model, enhance and extend HHM's investigative capabilities for exploring and modeling the various decompositions and submodels, and then extend the quantitative capabilities of HHM for resolving the conflict and overlap associated with the objectives of the various submodels.

HHM for Software Acquisition

Figure 2 depicts an HHM model for software acquisition. The six decompositions, or perspectives, of the software acquisition HHM indicate the multiple dimensions associated with software acquisition. The acquisition process requires the participation of numerous organizations and individuals with specific functions and responsibilities as well as requirements to coordinate their activities with the other parties. These organizations have their own goals and objectives, which are often in competition with each other. Risks and uncertainties inherent to the software acquisition process complicate the several key decisions that, in turn, affect the ultimate software product. Only by exploring the dimensions and perspectives of the overall systems acquisition and properly coordinating the objectives and requirements from each model perspective can one effectively manage the software acquisition process.

Software Acquisition Submodels. Software acquisition capability maturity implies the existence of, and adherence to, a specified, documented, and repeatable software acquisition *process* that is managed through *quantitative* strategies (Sherer and Cooper (draft) 1994). Therefore, prerequisite to a mature software acquisition customer community is the establishment, analysis, and acceptance of a software acquisition process as well as an appropriate quantitative management framework.

The multiple views the HHM provides are represented by the various hierarchical holographic submodels (HHSs), where each HHS addresses the system from one particular perspective, or dimension. As each perspective may have its own unique representation of issues, limitations, and factors, this diversity would likely lead to HHSs of different modeling topology, nature, or structure (e.g., analytical vs. descriptive models) (see Figure 3). For instance, the *process* view of the software acquisition HHM represents a progression of events or a sequence of decisions in the

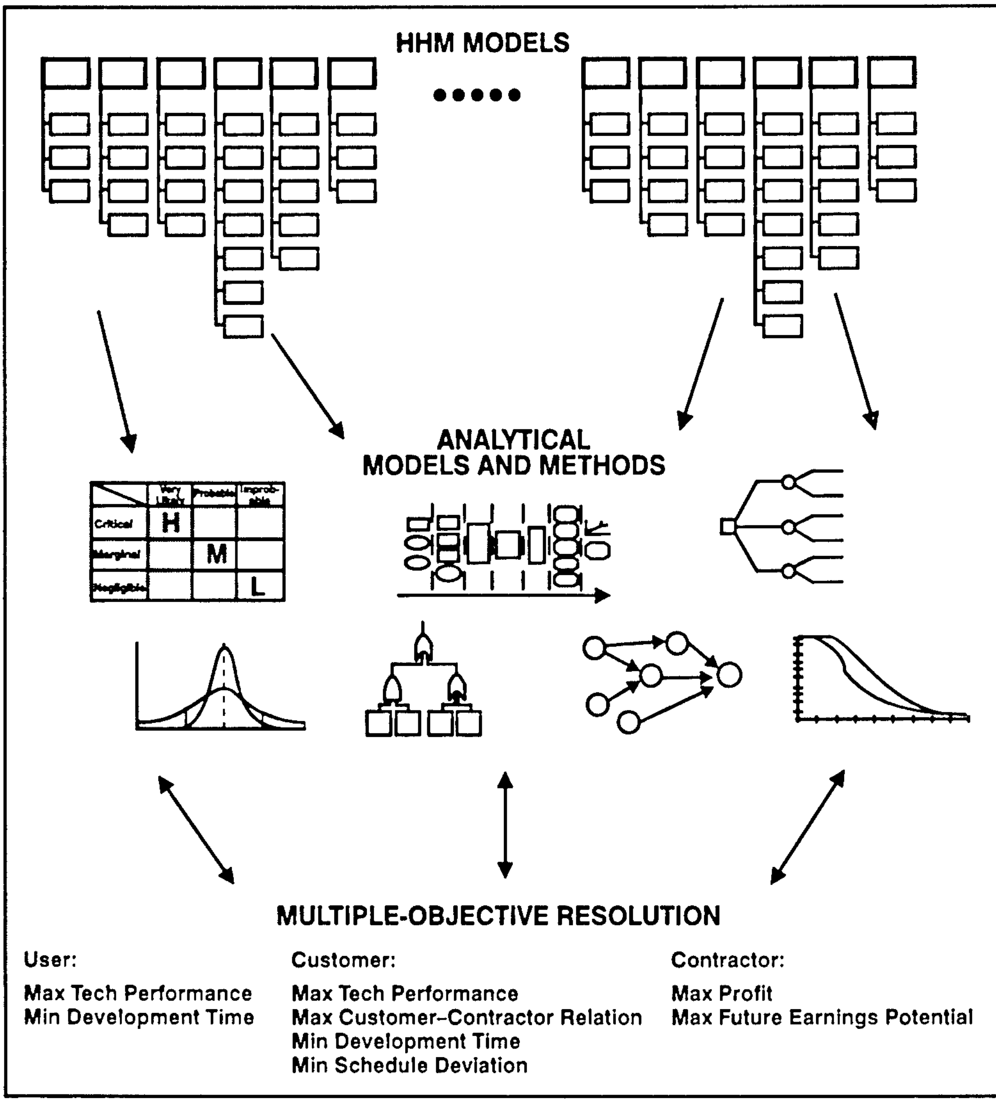


Figure 1. Quantitative Management Framework

software acquisition process that may be analyzed through process modeling (Blum, 1992), and then quantified by one of many appropriate tools, such as decision tree methods or multiple-objective decision tree methods (Haimes et al., 1990a). The *cost* element of the *program consequences* decomposition could be modeled by probability distribution analysis, supported by analytical software cost estimation models (e.g., constructive cost model (COCOMO) (Boehm, 1981)). The software *technical* element of the *program consequence* view may be quantified in terms of one of several measurable objectives (e.g., reliability, availability, maintainability) and may use fault tree analysis or Markov process models in its solu-

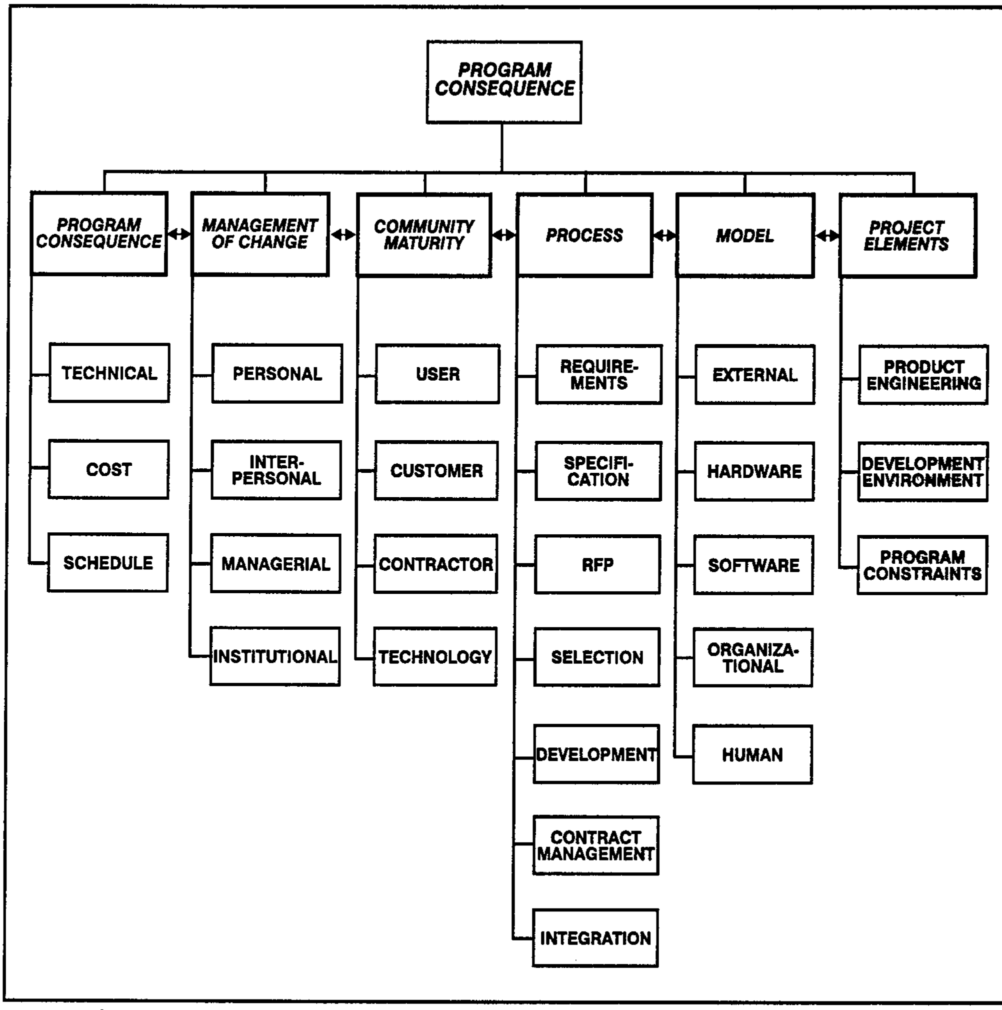


Figure 2. Hierarchical Holographic Model for Software Acquisition

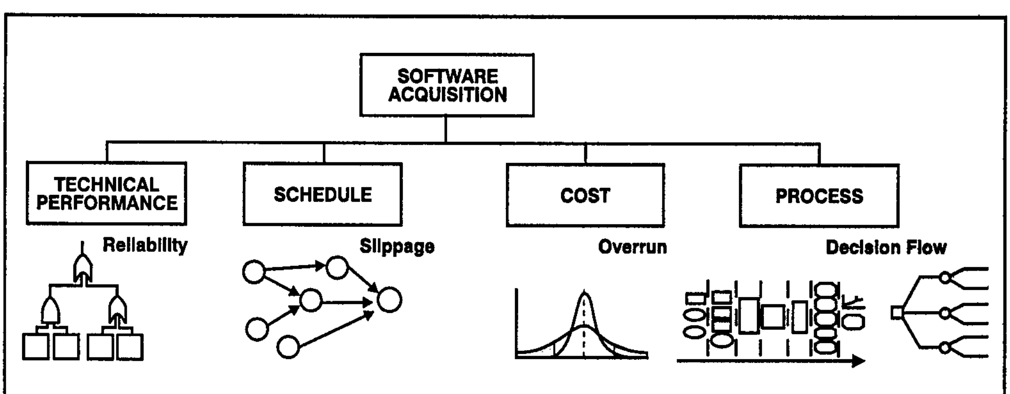


Figure 3. Demonstration of Analytic Methods for HHS Solution

tion (Johnson, 1989). Similarly, the *schedule* perspective may be analyzed through program evaluation review technique (PERT) or related methods (Boehm, 1981). While each HHS can then be solved independently, a coordinated solution to the overall problem must be resolved at the highest level of the HHM.

In this article, we focus on the *process* perspective of software acquisition, developing a modeling framework that describes the participants, inputs, activities, decisions, and interrelations of the various elements of software acquisition.

Multiple Objective Resolution. The full value of structuring the software acquisition analysis in this manner is realized by using a multiple-objective construct. Consider, for example, an over-simplification of the objectives of the end-user in a software acquisition effort. The user wants a system that achieves a high level of technical performance, and generally prefers that the system be developed and delivered as soon as possible. These statements can be formalized as F_1; maximize technical performance, and F_2; minimize development time, where F_i represents a specific objective. As Figure 1 shows, in addition to the user's multiple objectives, similar multiple statements can be expressed for the other participants in the software acquisition process.

The multiple-objective approach provides a context for achieving a "win-win-win" environment for the user, customer, and contractor. When associated with each view of the hierarchical holographic models, this approach not only provides a promising structure for resolving competition among participants, but also helps decison makers consider system trade offs such as between performance and cost, or between schedule and technology.

BACKGROUND: SOFTWARE ACQUISITION ISSUES

Major issues in software acquisition today include the criticality of the software component in modern systems, increasing pressure for reform initiatives, and the need for a less adversarial acquisition environment.

SOFTWARE'S CRITICALITY

As computer use has become central to organizational activities and engineering system design, the software component of these systems has become increasingly important. That criticality is well docu-

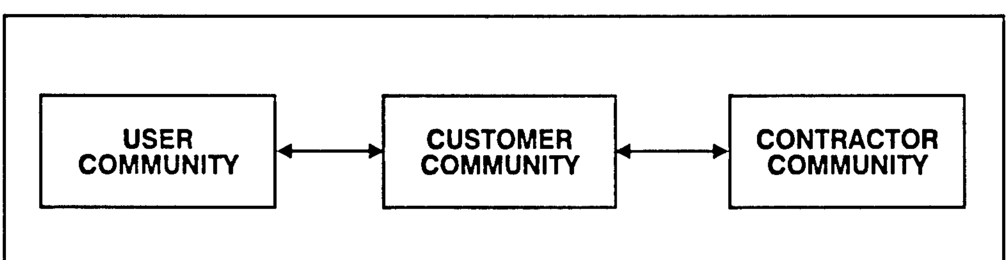


Figure 4. Hierarchical Holographic Model for Software Acquisition

mented and universally accepted (Boehm, 1984; Haimes and Chittister, 1993; Blum, 1992; GAO, 1990). Chittister and Haimes (1994a) document a shift in importance from hardware to software within modern systems. Software has become the principal system design component, as well as the principal factor affecting system quality. In fact, software has been described as the "Achilles' heel" of modern weapon systems because it is a key determinant of development schedules and because key functions such as navigation, enemy detection, and fire control depend on it (GAO, 1992b). Examples of system failures whose root was failure of the software have been well publicized (e.g., GAO, 1992a). Due to the continued expansion of software's commanding role in modern systems (and the budget for such systems), the ability to effectively acquire and integrate software into these systems will be increasingly important.

Participants in the Software Acquisition Process

The three principal participants, or groups of participants, in an acquisition endeavor are the user, the customer, and the contractor. In government acquisition, these groups rarely constitute single individuals, but each often comprises one or more organizations and their representatives. Under current practice the user and contractor communities generally communicate through the customer community (Figure 4). Re-engineering reform initiatives of the acquisition process would encourage more direct user-contractor communication.

In DoD acquisition activities, the user community may be a major Command from one of the services, a Unified or Joint Command, one of the military departments, or even DoD itself. Difficulties in directly identifying a single user or group of users are evident. Quite often, a representative user is designated to act on behalf of the larger user organization. In general, users are responsible for identifying and specifying operational needs, validating the criticality of those needs, and receiving the completed system.

The customer, which in DoD terms refers to the acquisition authority, and more specifically the acquisition managers and program managers, is the purchasing agent acting on behalf of the user. The customer is responsible for accurately translating the user's needs into the contractual language of systems requirements, writing the contract documents, selecting the best qualified contractor(s), monitoring system development, accomplishing contract management and negotiation functions, and conducting system testing and acceptance.

The contractor must develop a system that meets the requirements, guidelines, and limits stated in the contract. The ability of each participant to complete its task and effectively coordinate activities with the other participants is central to a successful acquisition program.

Software Acquisition Research

Software Development. Over the past three decades, software development practices and processes have been much studied. Early efforts to apply and extend the practices and principles of engineering to software led to the development of a new discipline: *software engineering*. More recent development of software life cycle models (Boehm, 1981) and software process development models (Feiler & Humphrey, 1992), have helped to bring a

Table 1. Initial Software Acquisition Maturity Model (SAMM), based on Sherer & Cooper (1994)

LEVEL	FOCUS	KEY PROCESS AREAS	RESULT
5 Optimizing	Process Optimization	Continuous Process Improvement Technology Insertion	Productivity & Quality
4 Controlled	Quantitative Management	Process Management Software Quality Management Defect Prevention Asset Management	
3 Defined	Integrated Project Management	Software Project Planning & Mgmt Process Focus Software Risk Management Project Team Coordination Software Engineering Monitoring Process Assurance Training	
2 Organized	Contract Management	Software Contracting Preparations Software Contract Initiation Requirements Management Software Contract Tracking Software Contract Oversight Acceptance, Transition, & Support	
1 Initial	Product and Resources		Risk

degree of standardization and process improvement to the software development community.

Much research has focused on improving the software development process (e.g., Humphrey & Kellner, 1989; Kellner, 1991; Heineman et al., 1994). Business realities such as strong competition, pressure for increased profits, and external regulations have spurred the momentum for an improved software development process (Austin & Paulish, 1993). Improving the software development capabilities of software vendors by improving their software development process maturity is the focus of the Software Engineering Institute's Capability Maturity Model (CMM) (Paulk, Weber, Garcia, Chrissis & Bush, 1993). This tool "provides software organizations with guidance on how to gain control of their process for developing and maintaining software and how to evolve toward a culture of software engineering excellence" (Paulk et al., 1992). Other related research including software process assessment, software metrics, CASE tools, software engineering, software quality, concurrent engineering, and software reliability engineering have been accomplished predominately on behalf of the software contractor, to aid in the actual develop-

ment of software and to provide visibility, through metrics, to the customer.

Software Acquisition Research. Unfortunately, when compared to software development research, relatively little has been studied and written for the customer's benefit, i.e., the development of guidelines and instruction of how to effectively acquire a software product and manage the acquisition effort. Recent, original work by Sherer and Cooper (1994) and parallel research (Baker, Cooper, Corson, & Stevens, 1994) have led to initial versions of a software acquisition maturity model (SAMM) for maturing the acquisition capabilities of the customer community. While the development of a SAMM is still in its infancy, and revisions of draft models are to be expected, the initial results appear promising. As with the CMM, the SAMM is both an evaluative tool as well as a way to increase a community's capability. An initial version of the SAMM (Table 1) proposes a structure of five progressive levels of maturity for software acquisition capability, along with key process areas for each level. Increasing the acquisition capability of the customer community improves productivity and program quality while reducing risk.

The maturity progression is intended as an upward flow: satisfying the requirements of one level leads to higher level functions. While a lower level organization may be practicing elements of a higher maturity level, full progression to the next higher level is contingent on all key process areas being fulfilled (Sherer & Cooper, 1994). Maturity in software acquisition capability implies a verified, repeatable, effective *process* and a *quantitative management* framework for governing that process. At Level 3 maturity, the customer employs an integrated project management, risk management, and process management strategy (Figure 5). Level 4, *quantitative management*, requires the customer to set and monitor quantitative quality goals for processes and products (Sherer & Cooper, 1994). The quantitative management framework described here establishes the necessary vision and practices required for the customer community's acquisition maturation.

Software Risk Research. As in many fields, software development has experienced its share of project disasters. Risk assessment and risk management specifically for software systems is a relatively recent area of research. Boehm's groundbreaking work (1981) introduced methods of decision making under uncertainty to this field. The Software Engineering Institute (SEI) of the Carnegie Mellon University, a federally funded research and development center with a broad charter to address software engineering technology, is a central participant in current software risk research. One of the SEI's focus areas is software risk management. The SEI risk paradigm (see Figure 5) depicts risk assessment and risk management as a process with several phases—identification, analysis, planning, tracking, and controlling functions—which parallel the general concepts of risk identification, risk quantification, risk analysis, risk management, and risk mitigation.

One of SEI's major functions has been to develop methodologies for addressing several of the software risk management phases. The Risk Taxonomy-Based

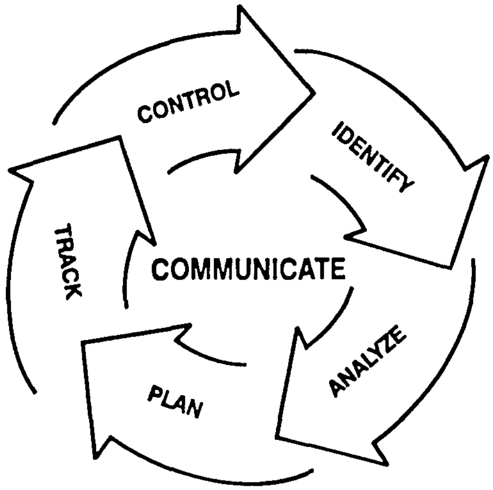


Figure 5. SEI Risk Management Paradigm, from Higuera et al. (1994)

Questionnaire (TBQ) is "a method for systematic and repeatable identification of risks associated with the development of a software-dependent project" (Carr, Konda, Monarch, Ulrich, & Walker, 1993). The Software Risk Evaluation (SRE) method (Sisti & Joseph, 1994) is a quantification method for assessing and analyzing risks for a project. A recent development, Team Risk Management (TRM) (Higuera et al., 1994), extends risk management practices to include team-oriented activities involving the customer and contractor, where these groups apply risk management methods together. TRM is a framework for cooperative risk management; it relies on strengthened risk communication between groups and incorporates the TBQ and SRE as fundamental risk analysis and assessment methods.

Acquisition Reform

Acquisition reform is currently a major initiative within government. The administration's *Plan for Economic Development in the Technology Sector* (Clinton and Gore, 1993) provides a broad plan to reinvent the federal acquisition system. The need for improvement has been expressed across government sectors. In a survey of senior executives in the federal government, a majority stated that "the procurement process frequently results in procurement decisions that are neither cost effective nor in the best interests of the government" (SAMERT, 1994). The Secretary of Defense stated that "the existing DoD acquisition system can be best characterized as an 'industrial era bureaucracy in an information age' " (Perry, 1994).

Although the defense acquisition system provides a structured, highly regulated process for systems acquisition, the regulations and restrictions imposed on the process over time have often hampered efforts toward efficiency and creativity. In

recent testimony before the Senate Committees on Governmental Affairs and Armed Services, the Undersecretary of Defense for Acquisition and Technology John Deutch, summarized the problem (1994):

> The system is too cumbersome and takes too long to satisfy customer requirements. In addition, the system adds cost to the product procured. DoD has been able to develop and acquire the best weapon and support systems, not *because* of the system, but in *spite* of it. And they did so at a price—both in terms of the sheer expense to the nation and eroded public confidence in the DoD acquisition system.

The dilemma facing any government acquisition reform is how to provide sufficient oversight for the expenditure of public funds, with the least amount of intrusive policy and regulation, yet still accomplish the acquisition goal. Acquisition reform must ensure the continued existence of important safeguards designed to ensure the integrity of the acquisition process. Reforms that reduce regulatory oversight may possibly increase the risk of mismanagement of public funds. Lawmakers often must balance the risks inherent in reducing oversight with the cost to industry and government to comply with oversight regulations.

Of particular concern regarding software acquisition are some of the key characteristics associated with software acquisition: Software evolves rapidly, it is difficult to explicitly define and specify, acquisition officials often lack software understanding, and there is difficulty in estimating project costs and time requirements. The current acquisition process requires an average of 16 years to field a new weapons system (Pages, 1994), while software and computer product life cycles are as short as 1 or 2 years. A software solution could become obsolete before it is delivered.

Other ongoing issues of software acquisition include: incentive-based contracting vehicles and their appropriate application, relaxation of "mil-spec" requirements procurement, and a move to commercial off-the-shelf (COTS) software purchases. DoD's acquisition system of audit activities, which includes the possibility of criminal sanctions for violating established procedures has cultivated a climate of adversarial relationships rather than partnerships between customer and contractor (Defense Science Board, September 1987). This has also led to a risk-adverse mentality for the program manager and the customer community; there is no reward for taking risks and huge penalties for failure. There is a strong need for a "win-win-win" environment for the user, customer, and contractor communities without the institutionalized mistrust of the current system.

Holographic Modeling for Software Acquisition

The dominating attributes of modern, large-scale systems are their multidimensional nature, hierarchical competing objectives, multiple participants, a wide array of pertinent issues demanding consideration, and inherent uncertainty. The complexity of the software acquisition process and the multiplicity of the parties

involved in that process from planning, to development, to delivery, and to maintenance defy the success of any attempt to represent this process by any one single model, structure, or paradigm. In fact, representation within a single model of all the aspects of a large-scale system is so impracticable as never to be seriously attempted. However, the inability to address this critical attribute of large-scale systems is a major stumbling block. As Haimes (1981) originally stated,

> To clarify and document not only the multiple components, objectives, and constraints of a system but also its welter of societal aspects (functional, temporal, geographical, economic, political, legal, environmental, sectoral, institutional, etc.) is quite impossible with a single model analysis and interpretation. Given this assumption and the notion that even present integrated models cannot adequately cover a system's aspects per se, the concept of hierarchical holographic modeling constitutes a comprehensive theoretical framework for systems modeling.

ACCEPTANCE OF THE HHM

Since its origin in 1981, the HHM has provided a general framework for addressing the modeling of complicated, multiple objective problems of large scale and scope. While not receiving an abundance of direct reference in the literature, nevertheless HHM's multivisionary approach to problem definition and risk identification has been widely, although often indirectly, accepted. For example, Yeh et al. (1991) reject the single-model, step-by-step approach in managing complex software engineering development. They state:

> In most current practice, decisions are based on a one-dimensional view prescribed by waterfall-like models. This view consists of a single explicit perspective on a set of activities and their interdependencies and schedule—which form an activity structure. In the waterfall model, the activities are sequentially scheduled into phases: requirements analysis, design, codes, tests, and so on. Other models suggest adding a second perspective, a communication structure ... still models like the spiral model of software development and enhancement and models based on process-maturity levels suggest including process design and monitoring.

Such an argument, highlighting the limitations of a single model to capture the multiple aspects of a complex system, underscores the contributions of the HHM approach. Even the title of a recent text, *Software Engineering: A Holistic View* (Blum, 1992), denotes the criticality of considering the multidimensionality of complex processes such as software development. Throughout his book, *Metasystems Methodology*, Hall (1989) uses HHM to recount the history of systems methodology, and to distinguish the varied applied systems methodologies from each other. He states:

> History becomes one model needed to give a rounded view of our subject within the philosophy of *hierarchical holographic modeling*, defined as using a family of models at

several levels to seek understanding of diverse aspects of a subject and thus comprehend the whole.

Many current risk identification methods, evaluation techniques, and issue investigation schemes build on the general principles embodied by the HHM. For example, careful examination of the SEI taxonomy (Carr et al., 1993), its purpose, and methodology indicate a vision that is harmonious with HHM: the taxonomy is hierarchical in structure, is constituted by progressive levels of detail and abstraction, provides a way to address the multiple dimensions of a problem, and serves to identify areas of concern in a software acquisition endeavor. Recognizing the kinship of these methods to the HHM strengthens the parent methodology, and further demonstrates the efficacy, appropriateness, and desirability of the HHM as a framework for analyzing software acquisition and other large-scale problems.

HHM for Software Acquisition

The role of models is to represent the intrinsic and indispensable properties that serve to characterize the system: that is, good models must capture the essence of the system. Clearly, the multidimensionality of the acquisition process, and the large number of groups, organizations, and people of many disciplines that are engaged in this process defy the capability of any single model to represent the essence of the acquisition process. To overcome the shortfalls of single planar models and to identify all sources of risk associated with the software acquisition process, an HHM framework will be adopted here. HHM assumes an iterative approach to providing the structure for identifying all risks. If one fails to identify a risk source with the current views of the HHM, then expansion of the model to include a new decomposition is possible. This process, itself, will eventually capture all risk sources.

The HHM developed here constitutes the six subdivisions or perspectives shown in Figure 2. Note that each subdivision is represented within the HHM framework by a separate submodel. This also implies that, when modeled, each of the six subdivisions and the corresponding sub-subdivisions will be represented by a set of objective functions; constraints; and decision, state, exogenous, and random variables. Obviously there will be common goals and objectives, as well as separate and possibly conflicting and competing objectives.

For notational purposes, the model of a subdivision will be termed hierarchical holographic submodel (HHS); thus, there are six HHSs in the HHM of the acquisition process. Here we do not delve into the theoretical and methodological grounding of the HHM as a decision making tool (see Haimes, 1981, Haimes, Tarvainen, Shima, & Thadathil, 1990); rather, we focus on the utility of the HHM framework as a mechanism for the assessment of risk associated with the software acquisition process.

HHM for Software Acquisition Risk Identification

HHM has been used successfully for risk identification in a wide variety of applications (Haimes et al., 1994). Using the software acquisition HHM model (Figure 2), a systemic exploration of the software acquisition risk can be conducted through the multiple visions of the model. As an

example, from the *program consequence* perspective, the software acquisition process may be divided into three consequence areas: technical, cost, and schedule.

1. *Technical.* In a software context, software technical consequences are concerned with the quality, precision, accuracy, and performance over time of the software.

2. *Cost.* Refers to the programmed and unexpected expenditures for procuring the software system, along with labor, capital, and other non-monetary costs.

3. *Schedule.* Concerns the establishment of, adherence to, and changes of a temporal development plan from which systems integration schedules and operational deployment schedules are based.

Figure 6 depicts one such representation from the perspective of *program consequence* HHS, focusing on the cost risks of the software acquisition effort—in particular, the cost risks associated with each community (user, customer, contractor, and technology).

Using the program consequence perspective as the primary vision, one may then examine all such consequences that emerge from the participant communities (e.g., What effects will the customer community have on the schedule?). Robust application of the HHM involves a thorough examination from multiple combinations of perspectives the consequences and factors associated with the software acquisition effort. Such a comprehensive analysis produces a wealth of understanding of the strengths and weaknesses associated with an acquisition effort, provides a framework for devising a management plan to deal with the identified shortcomings, and maintains the holistic perspective critical to program success.

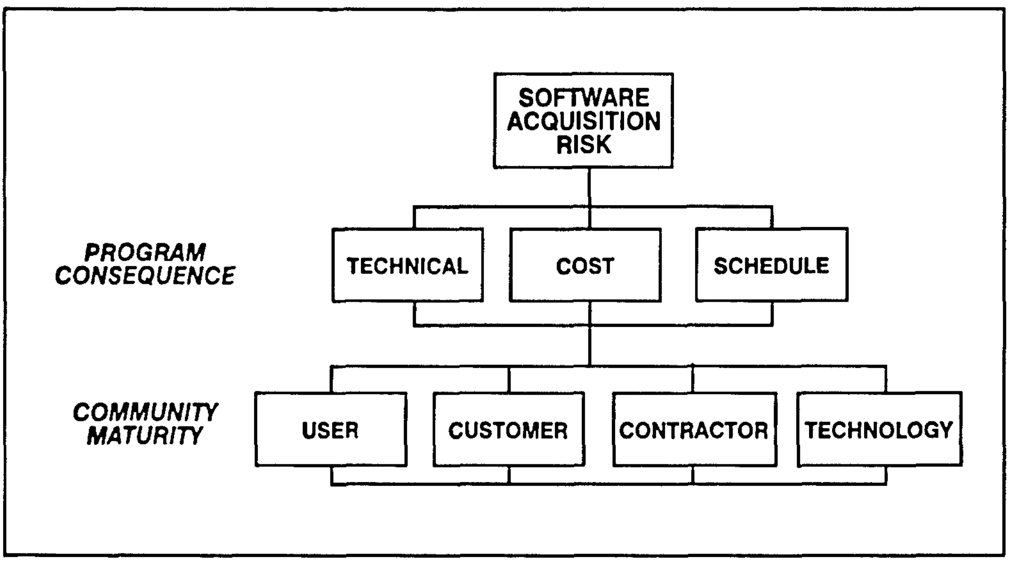


Figure 6. Program Consequence Submodel: Cost Focus

Software Acquisition Process Models

Each decomposition of the HHM depicted in Figure 2 provides a unique perspective for evaluating and describing software acquisition. In this section, we consider the *process* decomposition of the software acquisition HHM. Developing the process HHS allows one to focus on identifying, understanding, and modeling the progression of activities and interrelations associated with the software acquisition process.

Software Process Modeling

Discussion of the software process in the literature focuses primarily on software development processes and on the contractor's role in those processes. Often referred to as the software life cycle, the software development process is the collection of activities that begins with the identification of a need and concludes with the retirement of the software product that satisfies the need. Traditionally, the software process has been described in terms of the "waterfall model" (Boehm, 1976). In this model (which is an adaptation from the hardware development process model) there is a basic forward flow, or progression of activities and events. While the model presents a logical, organized approach, its inflexibility in adapting to the unique requirements of modern software development has led many to believe that this model is discredited (Blum, 1992). More recent representations of the software development process have included iterative, prototyping activities. For example, Boehm's spiral model (1988) consists of a series of learning cycles, with each iteration including the phases of identification, evaluation, planning, and testing. With each successive iteration, greater insight is gained, and system development is improved.

Most current software acquisition processes still follow a waterfall approach. One major initiative associated with current acquisition reform initiatives is modifying the existing process to better meet the unique requirements of software development. Improvements allowing for adaptive design, prototyping, and other iterative development approaches are being recommended (Scientific Advisory Board, 1994).

As software acquisition encompasses a range of activities and concerns far beyond that of merely developing a product, existing process models are inadequate for fully describing the software acquisition process. The process models developed in this section are descriptive in nature: they indicate the basic activities, events, interrelations, and functions of the software acquisition process as currently practiced (or as intended to be practiced). Realizing that analyses of the process and process improvement, alone, are not sufficient to accomplish the larger goal of improving software acquisition (Feiler, 1994), these models constitute an initial vehicle for examining the multiplicity of elements associated with software acquisition.

Software acquisition process models provide a representation of the progression of interrelated activities, the interactions of the participant communities, the functions that each participant accomplishes, and the means for analyzing the impact of these actions on the actual software acquisition effort. Each stage of the model consists of several elements or activities that define the principal contribu-

tion of that phase to the overall process. Before developing a fully detailed model, we first examine the essential elements and activities of the software acquisition process. Once these fundamental elements have been identified, we add complexity and detail to the model. Again, the intent is to describe the current process and to work within that context, not to prescribe an ideal process.

Essential Software Acquisition Process Model

Essence refers to the object of concern, or inherent nature of an activity (Brooks, 1987). Using this definition, the essence of the software acquisition process is finding a solution that meets the stated need. By initially focusing on the essence of this process, we will have a context from which to address the more detailed issues that complicate the process' effectiveness.

Abstraction of the software acquisition process leads to the simplified model shown in Figure 7. This model takes the user's perceived real-world need as input and produces a solution to meet that need. The model contains three translation activities, which together represent a transformation from a stated need to a solution:

1. From the user's real-world statement of need to a requirements statement that details an intended solution for the need.

2. From the requirements specification statement to a development and specification statement. This statement includes the details of design, process, and evaluation along with the method of selecting a contractor to implement the development plan.

3. From the development statement to an actual system that satisfies the user's real-world need.

The model highlights the understanding each participant community must have of its role in the process. As requirements are developed from input originating in the user's domain, the customer must understand the user's domain and then be

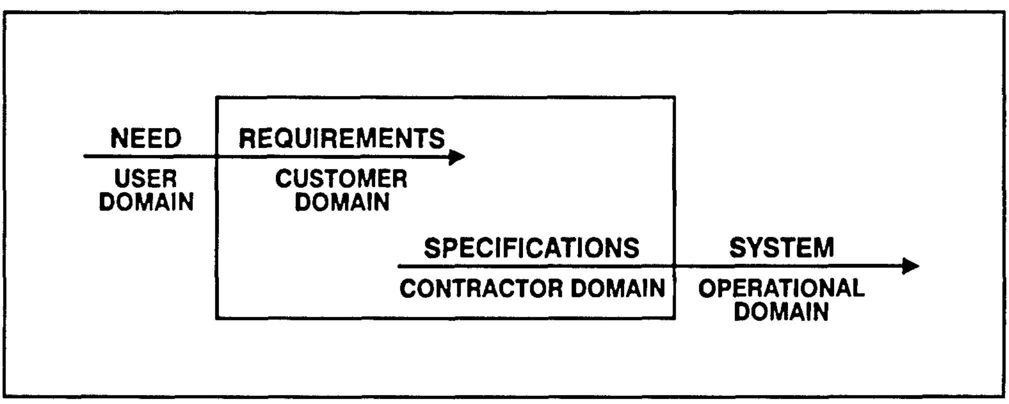


Figure 7. Essential Software Acquisition Process Model, adapted from Blum (1987)

able to generate system requirements that are usable by the contractor. These requirements, however, are not specific enough to provide sufficient detail to fully define the intended system. Therefore, requirements must be translated into more formal, detailed system design and development statements. The contractor's understanding of software tools and environments must also extend to an understanding of the implementation domain—that domain in which the developed system will operate.

The essential model explains why the software acquisition process is so complicated: It requires the coordinated activities of several participant communities, necessitates experience in several domains, and depends on a series of difficult translation activities. As software continues to assume a greater role in modern systems, the difficulties of software acquisition become the overriding difficulties in systems acquisition. Technology is changing so rapidly, and communication between the three communities is getting increasingly complicated, especially because of DoD's demanding operational needs that precipitate the requirement for state-of-the-art systems. These facts constitute the driving force of the software acquisition process.

Detailed Software Acquisition Process Model

Expanding the level of detail included in the essential model leads to the model depicted in Figure 8. The seven stages of the detailed model parallel that depicted

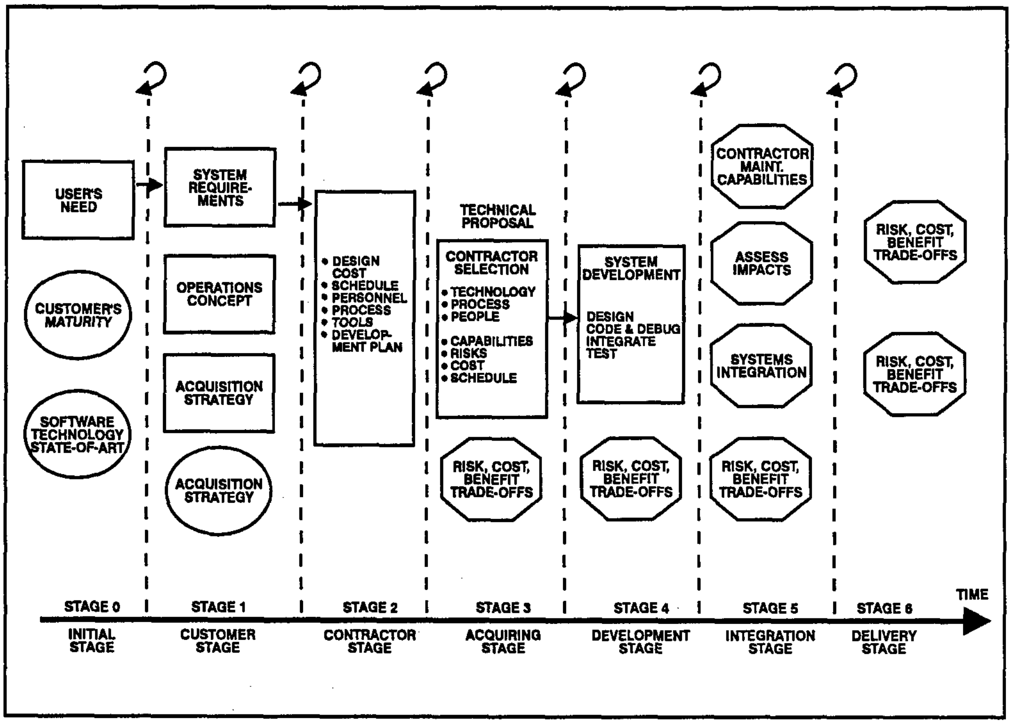


Figure 8. Detailed Software Acquisition Process Model

in Figure 7. Stage 0 corresponds to the input to the model, the need developed by the user; stage 1 parallels requirements specification; stages 2, 3 and 4 are an expanded treatment of the development activity; and stages 5 and 6 constitute the system phase of the previous model.

In Figure 8, boxes represent an activity or function to be accomplished. Circles indicate current information, state of events, or other contributing factors that cannot be manipulated by decisions made in the acquisition effort. Octagons indicate output results that require monitoring and managing and are affected by decisions made by the participants in the acquisition effort. The three arrows indicate the three translation activities. The curved arrows above each stage's boundary indicate the possibility for iteration in the process. While not institutionalized in the current process, reform initiatives and reengineering activities indicate a growing support for an iterative path through the acquisition process.

Stage 0: Initial Stage. This stage is a precursor to the actual acquisition activities; however, the initial actions and abilities that proceed from this stage affect the balance of the acquisition effort. Although this stage involves both the user and customer communities, their actions at this point are independent of one another. The user, based on operational experience and training, develops an operational need, provides a review process to formalize, validate, and prioritize the need, and forwards this need to the appropriate acquisition liaison agency.

Stage 0 also comprises the baseline levels for two key elements: state-of-the-art software technology, and customer maturity. Recent investigation has shown that "application-knowledgeable, technically skilled leaders are the military's limiting resource in acquiring today's computer technology" (SAMERT, 1994).

The continued downsizing of the federal government, and the DoD in particular, further exacerbates this problem. Many highly qualified acquisition officials are taking advantage of incentives for early retirement, realizing that their skills are in great demand outside of government service. Where will DoD's needed technical experience and expertise come from? The essential key to an acquisition program's success is the technical maturity of the customer community: their knowledge of software and software acquisition, the ability to understand and translate user needs, establish requirements, develop and manage contracts, select and monitor appropriate metrics, and select the proper contractor. Hence the need for continued development of a software acquisition maturity model (SAMM) (Sherer & Cooper, 1994) aimed at evaluating a customer organization's maturity level and providing a road map for improving its capability.

Stage 1. Customer Actions. Following the user's development and validation of an operational need, the customer agency then begins the task of managing the acquisition of a software solution. The first translation activity, transforming the operationally-based language of the user's need to the contractual language of systems requirements, is completed at this point.

A requirement is a "function or characteristic of a system that is necessary; the quantifiable and verifiable behaviors that

a system must possess and constraints that a system must work within" (Christel & Kang, 1992). Requirements generally specify "what" the system requires in terms of functions and data, and "how well" the system must perform relative to the goals and objectives of the system (Ashworth, 1989).

The output of the requirements identification activity is a formal statement that captures the full intent of the user community's need and communicates this in appropriate language to the contractor community (in DoD, the result is called a request for proposal [RFP]). In this light, requirements analysis is the bridge between user needs and system specifications from which a solution can be developed (Przemieniecki, 1993). Errors in requirements definition can pass through undetected to later stages of the acquisition process, possibly not realized until a deficiency arises at system implementation. Greater discussion of the art and process of requirements elicitation and development can be found elsewhere (Christel & Kang, 1992; Southwell et al., 1987; Rzepka, 1989; and Fickas & Nagarajan, 1988).

Stage 2. Contractor Actions. While some contractor involvement may be solicited during requirements generation, this stage marks the formal introduction of the contractor to the acquisition process. Candidate contractors conduct the second translation activity associated with the acquisition effort by responding to the requirements specification with their detailed development plan. This plan typically includes a description of the design for the intended system, its size, structure, complexity, and other descriptor information. Statements of technology requirements, development environment, development tools, personnel, management, and other organizational and technical issues are also included along with cost and schedule figures.

While the user and customer may have spent considerable time in accomplishing stages 0 and 1, quite often the contractor completes stage 2 in a matter of weeks. Such a time constraint raises important questions concerning the reliability of the contractor's estimates. For instance, how accurate are a contractor's estimates concerning a project that will require technology beyond current capabilities, relying on the development of yet-to-be technology. Other important questions (Haimes & Chittister, 1993) are: do developers with little experience overestimate or underestimate cost and schedule, and do developers with experience overestimate or underestimate cost and schedule?

Stage 3. Acquiring Stage. Some time before proposals are received, the customer determines the evaluation standards upon which all proposals will be scrutinized and evaluated. Organizational capabilities, performance history, cost estimate practices, as well as metrics for evaluating other performance criteria are considered. Other key areas of interest include the contractor's statements regarding technologies, development processes, and capabilities.

Generally, during contractor selection, the customer is faced with a wealth of information—some pertinent, some not. What is needed is a method for determining what the customer needs to know, a process to synthesize and filter the data, and a structured process for using the information to choose the contractor.

Stage 4. System Development. In this stage, the selected contractor implements the development plan and actually produces the software system. Most likely, instead of a single contractor, a contractor consortium of teams of major companies collaborate in the development of a system. The majority of software acquisition and development research has focused on the activities of this stage. The well-known waterfall models of the software development life cycle (Royce, 1970; Boehm, 1981) are models of the activities of this stage. More recent research on software development are also principally concerned with this stage's events (Boehm, 1988; Sage, 1992; Feiler & Humphrey, 1992; Heineman et al., 1994).

Stage 5. Integration. As system development progresses to an initial operating capability, the contractor, customer, and user coordinate the acceptance testing of the system. The success of this stage hinges on the combined work and decisions that stem from previous stages. Systems integration is the dominant activity here; the components are integrated with other system elements. Increasingly, software is the vehicle for accomplishing systems integration and assuring system success (Chittister & Haimes, 1994b).

At this stage, previously identified technical and nontechnical risks have the greatest likelihood of materializing. These risks may have existed all along, and come to the surface during the activities of system integration. In order to most effectively plan for and manage the systems integration activity and the risks that may arise, the customer organization must make critical trade offs between costs, benefits, and risks associated with each policy option.

Stage 6. Delivery. Only when at full operating capacity and beyond can the value of risk mitigation and risk prevention efforts be fully realized. Often, selection of a risk mitigation strategy is based on prevention versus correction—that is, a proactive approach versus a "wait and see" approach: "Early defect fixes are typically two orders of magnitude cheaper than late defect fixes, and the early requirements and design defects typically have more serious operational consequences" (DoD, 1991).

Maintenance and modification initiatives with their associated costs and impact on operational capabilities are principal concerns of this stage. This stage is also the link for returning to stage 0 in the next acquisition effort. If the customer (or user, or contractor) captures the knowledge gained through this acquisition experience and uses it to increase the abilities of their organization (e.g., via training or documentation), then this community's maturity level is increased. They will be better prepared for dealing with the next acquisition effort.

Analysis and Extension through Process Models

The process models developed in this section provide a framework for a more detailed understanding of the interrelations and activities associated with the current software acquisition process. Each phase of the process can be explored in greater depth using the HHM model (Figure 2). The process models also provide the construct from which an iterative software acquisition process could be modeled. These models are an effective vehicle for understanding the required interconnections, mechanisms, information, and ac-

tivities that must be included in such an innovative paradigm.

Extended HHM for Coordinated Submodel Solution

This section describes two additional software acquisition hierarchical holographic submodels, *program consequence*, and *community maturity*, and presents an approach to resolving the inherent conflict in the analytic modeling associated with these submodels.

Program Consequence HHS

The program consequence HHS of the software acquisition HHM addresses the need to synthesize vast amounts of information concerning the suitability of a proposed system for meeting an operational need. This includes analysis of the proposed system design, estimates of the design's technical performance, development cost, and schedule estimates, and other relevant factors. The trade offs between performance, cost, schedule, and the risks in each area are considered in this activity.

The multiple factors associated with the program consequence HHS (Figure 9) may be viewed as submodels of this HHS. Each sub-submodel may be quantified and analyzed by way of an appropriate model (analytic or descriptive), with the requirement for an overall resolution at the HHS level.

Software technical performance may be quantified in terms of one of several measurable objectives (e.g., reliability, availability, maintainability) and is best analyzed through fault tree modeling or Markov process modeling (Johnson, 1989; Kanoun et al., 1993; Tai et al., 1993). While several software cost estimation models exist (e.g., Boehm, 1981; Charette, 1989; Pressman, 1987), each generally produces a single-point estimate of the projected development cost. The cost risk-mitigation approach of Haimes and

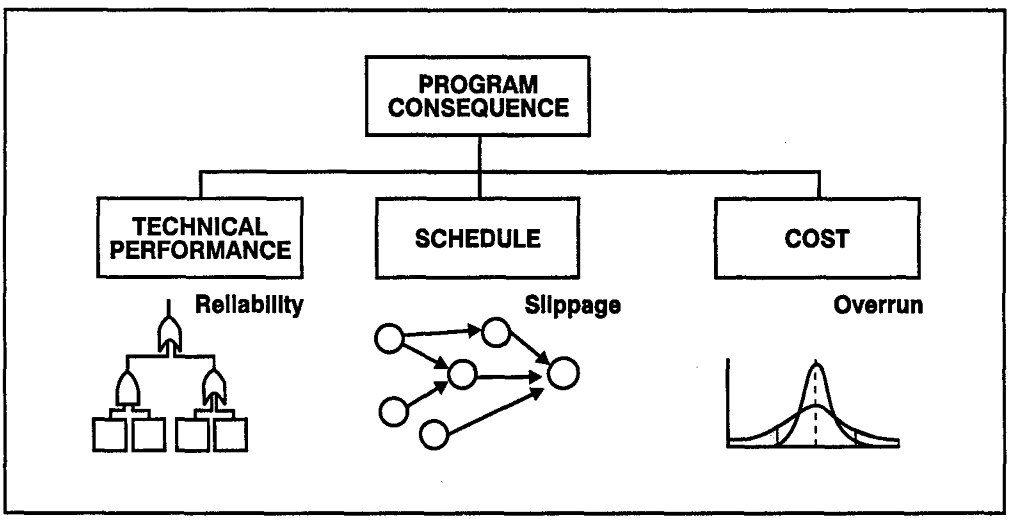


Figure 9. Program Consequence HHS Sub-submodels

Table 2. Multiple Objectives of Acquisition Process Participants

PARTICIPANT	OBJECTIVE	
USER	MAXIMIZE MINIMIZE	TECHNICAL PERFORMANCE DEVELOPMENT TIME
CUSTOMER	MAXIMIZE MAXIMIZE MINIMIZE MINIMIZE	TECHNICAL PERFORMANCE CUSTOMER-CONTRACTOR RELATION COST DEVIATION FROM TIME SCHEDULE
CONTRACTOR	MAXIMIZE MAXIMIZE	PROFIT FUTURE EARNINGS POTENTIAL

Chittister (1993) is an improved approach, employing a probabilistic, extreme event cost analysis methodology that allows incorporation of cost estimation model results. Software project scheduling, most often modeled through PERT (Project Evaluation and Review Technique) or CPM (Critical Path Method) models (Charette, 1989), also has probabilistic extensions (Abdel-Hamid & Madnick 1983; Haimes et al., 1994). While each of the three sub-submodels can be analyzed and solved independently, overlapping objectives and constraints require that a managed, coordinated solution to the overall problem be resolved at the HHS level.

Community Maturity HHS

The *community maturity* HHS captures the competing, yet overlapping objectives of the three participant groups. This HHS can, in some ways, be viewed as an extension of the program consequence HHS. Each participant community is further represented by its own sub-HHS, with only those consequences applicable to each participant group considered in the submodels.

In an acquisition effort the user's primary objective is to meet all of the operational needs. This objective could be stated as acquiring a system that maximizes technical performance. Generally, this is not the only objective for the user. Getting the system as soon as possible—minimizing development time—may also be important. The customer has a similar, but different multiple-objective problem: to minimize cost, maximize technical performance, enforce a contractual time schedule, and maximize contractor–customer communication. The contractor also has a multiple-objective problem: maximize profit and maximize potential for future earnings (additional contracts). An example of these multiple objectives, at least one for each of the acquisition process participants, is represented in Table 2.

Obviously, some of these objectives are competing both within a participant's individual problem (maximize technical performance versus minimize cost) and between participants (maximize contractor's profit

versus minimize customer's cost). A common DoD contracting practice is to fix profit margin; under such restrictions, the only way for a contractor to increase earnings is by spending more, thereby increasing the overall program cost. A contractor can also earn more with each deviation and modification to the contract. The more deviation, the greater the contractor's earnings. These realities are in direct competition to the customer's goals of minimizing cost and contract deviations. There are overlaps between the objectives of the three participants, yet there are certain objectives unique to each individual problem. Adequate coordination of these multiobjective problems is the key to a mutually agreeable solution.

As Figure 10 shows, analytic methodologies appropriate for analyzing each of the submodel objectives may not necessarily assume the same form. At least one objective, the customer's desire for good relations with the contractor, may be unrepresentable mathematically. Some indication concerning this objective, however, may be analyzed through a classification model based on HHM analysis of the characteristics and capabilities of the particular contractor. Each sub-HHS model is itself a multiple objective model, and the result of the three participant community solutions must be resolved at the overall HHS level.

Similar multiobjective problems can be derived for each HHS of the HHM. For instance, maximizing technical performance may include the subobjectives of maximizing reliability, number of computations per second, system availability, or some other system performance feature. To a certain extent, each of these subobjectives is in conflict with the others—for example, a system designed for

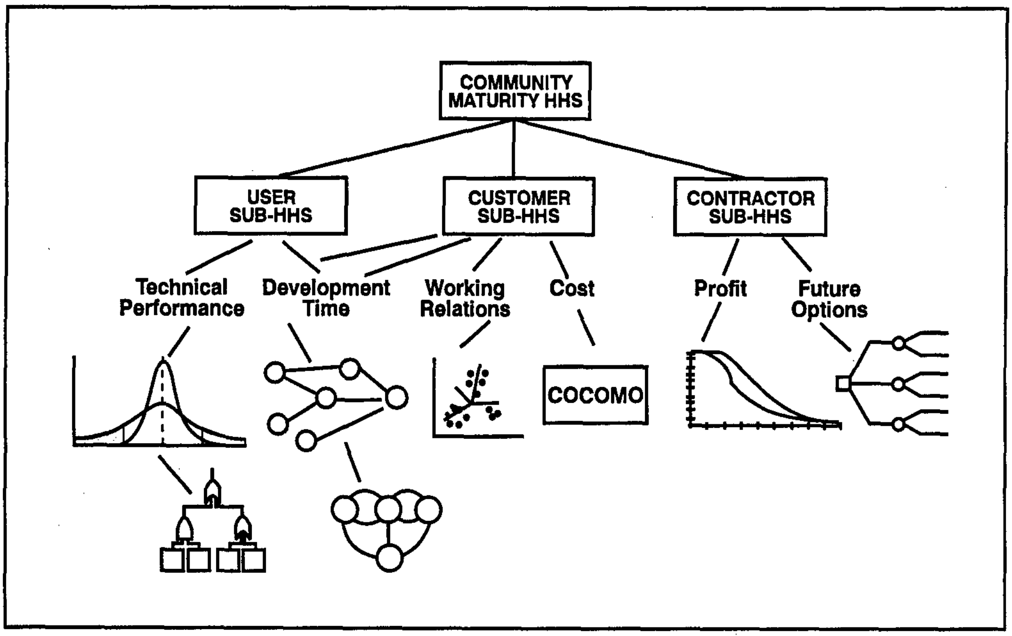


Figure 10. Community Maturity HHS

computational speed may not be extremely reliable. Including cost minimization as a subobjective may introduce additional conflicts (e.g., a highly reliable system is generally not the low-cost option). The practical reality of software acquisition demonstrates that it must be described in terms of multiple, multiobjective problems that are conflicting, possible overlapping, and exhibit a hierarchical structure.

HHM: Model Management for Submodel Conflict Resolution

The quantitative framework described in this paper is founded on the synergistic coupling of the HHM and process models, and the incorporation of other appropriate models, methods, and tools to effectively analyze and support decision making throughout the acquisition process. Figure 1 shows a representation of this framework. While each of the many methods and tools has been designed for its own unique purpose, each may give a greater contribution when coordinated with the results of other methods. A holistic vision ensures that methodologies are not employed for their own sake (sublevel optimization), but that each contributes to the overall system goals and objectives. In this manner, we achieve analytic progression through the complex acquisition process.

The field of model management, a growing area of study, recognizes that complex problems rarely can be solved by a single model encompassing all problem aspects. Solutions to such problems often require the integration of multiple models each addressing a specific aspect of the problem (Mitra & Dutta, 1994). Model management methodologies provide approaches for combining several models into an integrated model that is sufficient to solve a given problem (Basu & Blanning, 1994). While several approaches have been proposed (e.g., database management, artificial intelligence, conceptual graphs), the most promising and easily implemented are those of the graphical approach. These methods provide a framework for model composition by identifying models that may be combined into a composite model (Muhanna & Pick, 1994). The HHM can appropriately be considered as a model management methodology; resolution of the higher level model requires the coordinated solution of multiple submodels. HHM's unique handling of overlapping objectives and program constraints is particularly desirable. While the original HHM assumes that each submodel has a mathematical programming formulation, relaxing this requirement provides a means for resolving the more realistic problem where submodels have diverse analytic constructs.

HHM provides the framework for representing the software acquisition submodels in terms of hierarchical multiobjective decision models (MODM). The MODM approach provides a context for a "win-win-win" environment, as a solution that is mutually acceptable to all three participants would be found in the set of nondominated solutions to the coordinated multiobjective problem (Chankong & Haimes, 1983). The multiobjective modeling approach also provides a structure for resolving competition between issues, such as the trade off between performance and cost, or between schedule versus technology.

Formulation of a hierarchical multiobjective problem, taken from the frame-

work of the HHM, implies the formal evaluation of model elements and data requirements (random variables, decision variables, state variables, functional relationships, etc.). Such a comprehensive effort not only establishes an overall analytical framework for reaching an agreeable solution, but also provides greater insight and understanding as to the interrelationships and structure of the software acquisition process.

When a purely analytic approach for resolving HHS conflicts is not possible, it may be necessary to consider conflict resolution strategies (Fraser & Hipel, 1984; Raiffa, 1982), trade off methodologies (Chankong & Haimes, 1983), and negotiation strategies (Nierenberg, 1978). The *community maturity* and *program consequence* problems described above are not ones of simple multiple-objective resolution due to the overlapping and coordination inherent in the HHM/HHS structure—therefore application of conflict resolution strategies must consider the unique characteristics of hierarchical, overlapping, and yet conflicting problems. Other possible approaches to be explored include some variation of a weighting scheme (Chankong & Haimes, 1983), where each HHS or even each objective is assigned a weight—directly or by a pairwise comparison—to determine preference for each objective and submodel. The analytic hierarchy process (AHP) (Saaty, 1990) may be useful for such an approach. Other trade off methods, such as the surrogate worth trade off (SWT) method (Chankong & Haimes, 1983) may also prove useful.

CONCLUSION

The holistic approach to software acquisition management presented in this paper provides a theoretical, as well as methodological approach, for a maturing software acquisition community. This approach compliments the maturity progression described in the SAMM. Figure 11 summarizes the relationship between management maturity and quantitative risk management methods. With the SAMM, progression to higher maturity levels assumes the continuation of all lower level activities and methods, while adding new functions and processes. Similarly, with the quantitative risk management framework, holistic models build on the descriptive foundation of the process models; used together they provide even greater information and insight. As with the SAMM, lower level organizations may make use of some of the higher level methods, but have not employed all the functions required to fully progress to that higher level. The focus of each analytic method parallels the focus of the related management level.

Here we've detailed a holistic approach to the analysis of the software acquisition process and to the development of a quantitative management framework needed for the maturing of the software acquisition customer community. This framework is founded on the multiple visions of the HHM and the temporal progression of activities captured in the process models. It provides the means for incorporating appropriate analytic models and methodologies for a systemic approach to quantitative management of software acquisition. The competing interests of the participants, con-

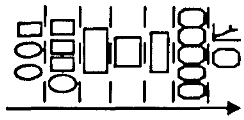
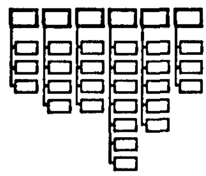
SOFTWARE ACQUISITION MATURITY MODEL		QUANTITATIVE RISK MANAGEMENT FRAMEWORK	
MATURITY LEVEL	FOCUS	ANALYTIC METHOD	METHOD FOCUS
2 - ORGANIZED	CONTRACT MANAGEMENT	PROCESS MODEL 	DESCRIPTIVE
3 - DEFINED	INTEGRATED PROJECT MANAGEMENT	HOLISTIC MODEL 	IDENTIFICATION/ QUANTIFICATION
4 - CONTROLLED	QUANTITATIVE MANAGEMENT	QUANTITATIVE MODELS 	QUANTITATIVE ANALYSIS
5 - OPTIMIZING	PROCESS OPTIMIZATION	MULTI-OBJECTIVE MODELS USER: MAX F_1 MIN F_2 CUSTOMER: MAX F_3 MIN F_4 MIN F_5	OPTIMIZATION

Figure 11. SAMM and Quantitative Management Framework Comparisons

flicting performance measures, and uncertain system requirements make a multiple-objective approach for analyzing and resolving these conflicts appropriate.

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REENGINEERING THE RFP PROCESS THROUGH KNOWLEDGE-BASED SYSTEMS

Dr. Mark E. Nissen

Acquisition plays a vital role in national defense of the United States. But, defense acquisition can be quite difficult, and few would argue that current acquisition processes perform in an optimal manner. The magnitude of change mandated by FASA and DAWIA, along with changes mandated from within DoD, is such that "business as usual" no longer represents a viable alternative for acquisition management. The military procurement process in general requires reengineering, and the research described in this paper focuses upon the Request for Proposal (RFP) subprocess in particular. The use and utility of a knowledge-based system to support process redesign are demonstrated, and insight is provided into the potential of AI-based technologies to dramatically improve military procurement. The results provide the basis for a number of conclusions that are important for the acquisition professional, and establish an agenda for future research.

Acquisition plays a vital role in national defense of the United States. The armed forces depend on the acquisition of high-quality and reliable weapon systems, equipment, support, and services for their defense missions, in peacetime as well as during periods of international tension and conflict. But getting what is needed can be quite difficult. Because many of these systems are exceedingly sophisticated, complex, and expensive, their procurement is complicated and involved. Further, those whose job it is to acquire systems and services work in an environment of arcane laws, regulations, policies, and procedures, for which a considerable investment in education and training is required. And, this legal and regulatory environment is constantly changing, which requires vigilant attention and incessant retraining of acquisition professionals so that their knowledge remains current.

Moreover, few would argue that current acquisition processes perform in an optimal manner. Rather, the costs required to staff and manage defense procurement consume a substantial portion of acquisition funding, and procurement administrative lead time (PALT) represents a major factor in weapon system planning and logistics. Indeed, legislation such as the Federal Acquisition Streamlining Act (FASA) and the Defense Acquisition

Workforce Improvement Act (DAWIA), along with changes (e.g., performance specifications and standards, preference for commercial items, integrated process teams) mandated from within the Department of Defense (DoD), require dramatic improvement in performance of the military procurement process. To exacerbate the difficulties inherent in this performance-improvement task, the mandates come at a time when defense appropriations are declining substantially, acquisition staffs are getting much smaller, and many procurement organizations are now obligated to fund themselves on a fee-for-service basis (i.e., Defense Business Operations Fund (DBOF)).

The magnitude of required improvement is such that "business as usual" no longer represents a viable alternative for acquisition management. Neither can management expect to achieve process improvements of the magnitude required through the incremental methods (Hammer & Champy, 1993) of continuous process improvement (CPI); rather, the kinds of dramatic performance improvements that are needed call for radical process redesign (Hammer, 1990)—that is, the military procurement process requires reengineering.

REENGINEERING

Business process reengineering (BPR)—which is also referred to as business engineering (van Mael, 1993), process innovation (Davenport, 1993), process redesign (Davenport & Short, 1990), and simply reengineering (Hammer, 1990)—has been defined as "... the *fundamental* rethinking and *radical* redesign of business processes to achieve *dramatic* improvements in critical, contemporary measures such as cost, quality, service, and speed [emphasis added]" (Hammer & Champy, 1993, p. 32). The *fundamental* nature of reengineering relates to questioning assumptions; that is, taking nothing about a business or organization as fixed or given, and challenging the appropriateness and existence of every aspect of business organization and operation. "Radical" redesign refers to transforming even the most enduring, stable, and central aspects of a design configuration, and envisioning new redesign alternatives without limitations or constraints associated with a current design. "Dramatic" improvement implies that the level of performance is expected to increase by several fold (e.g., $2x$, $5x$), as opposed to incremental improvements that are generally measured in percentages (e.g., 5%, 20%).

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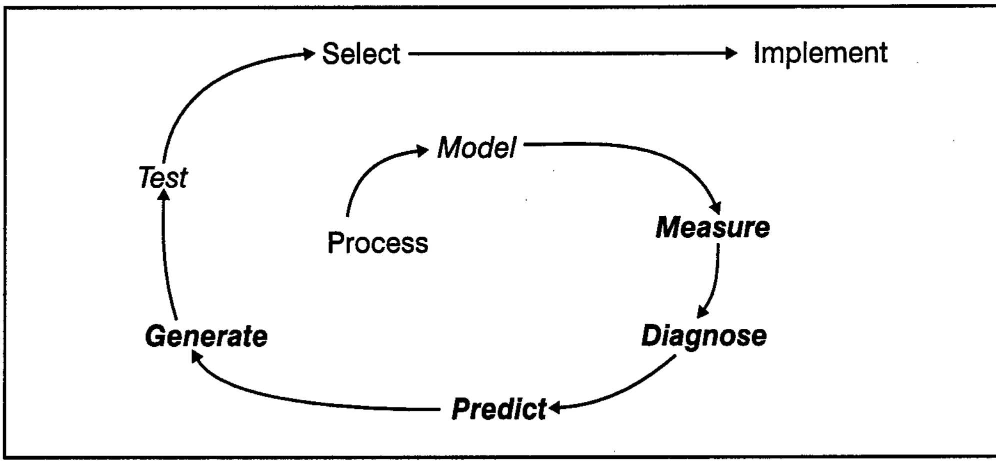

Figure 1. KOPeR Redesign Methodology

Although the focus of BPR has been primarily on the private sector, many federal agencies are also actively involved with reengineering. These federal reengineering endeavors generally fall under the rubric of the "reinventing government" program (U.S. Government, 1993a), and have led to the development of several "reinvention labs" (U.S. Government, 1993b) across the country. Numerous cases of reengineering in the government sector can be found in Electronic College (1996). Although military organizations and processes have a number of unique attributes, many of the tools, technologies, methods, and redesigns from *business* process reengineering apply equally well to *organizational* processes such as military procurement. One such currently emerging technology is knowledge-based reengineering.

Knowledge-Based Reengineering

The term *knowledge-based reengineering* refers to the use of knowledge-based systems (KBSs) to automate and support process redesign. Integrating some powerful methods and technologies of artificial intelligence (AI) with a number of expert reengineering methodologies from the consulting practice, the knowledge-based system KOPeR (knowledge-based organizational process redesign) (pronounced "cope-er") was designed to provide automated reengineering support (Nissen, 1995). The KOPeR design draws from the AI methods and technologies that led to the development of many powerful KBSs, each of which has enabled dramatic improvements in organizational processes. These include, for example, the R1/XCON system (McDermott, 1982), MYCIN (Shortliffe, 1976), SOPHIE (Brown et al., 1982), the CLUES system, and the Authorizer's Assistant (Laudon & Laudon, 1994, pp. 599, 606). Many such "intelligent" systems have demonstrated professional levels of performance that meet and exceed those of engineers, physicians, and financial managers.

Figure 1 delineates the *redesign methodology* supported by KOPeR. An orga-

nizational process in the field is first represented in terms of a computer-based model; such computer-based modeling now represents standard reengineering practice, and the Integrated Definition family (e.g., IDEF 0, IDEF 3) provides a standardized representational formalism for modeling organizational processes. Because the IDEF (and nearly all other BPR modeling) tools are graph-based (i.e., comprised of nodes, edges, and attributes), a battery of graph-based diagnostic process measures can be obtained *automatically* by KOPeR. As diagnostics, these measurements are used to detect the severe pathologies and faults associated with a process, and KOPeR employs its base of formalized reengineering knowledge (i.e., knowledge base) to predict which redesign transformations are most likely to effect dramatic improvement in process performance. These transformations are then applied to the baseline (i.e., "as is") process model to generate one or more redesign alternatives for the process (i.e., the "to be" scenarios).

"KOPeR and its corresponding redesign methodology were used in an investigation to reengineer several processes associated with military procurement."

Finally, once a *dynamic* process model has been validated and calibrated against the process baseline, simulation is employed to test the performance of each redesign alternative. This represents a very efficient technique to evaluate alternate process redesigns, and to reduce the inherent risks of reengineering before committing time and money to a problematic implementation. Standard methods of evaluation and decision making (e.g., cost/benefit analysis, functional economic analysis, multi-attribute decision making, etc.) can be used to select the highest potential redesign alternative, which then becomes the focus of organizational planning and implementation.

Reengineering the RFP Process

KOPeR and its corresponding redesign methodology were used in an investigation to reengineer several processes associated with military procurement. A major Navy procurement organization was the focus of this investigation, in part because its organization, processes, and technologies appear to be representative of those found across any number of military sites and bases; hence the results from this investigation are inherently generalizable, not only to other Navy organizations, but to procurement processes across the range of service components, government agencies, and major corporations. This Navy procurement organization is part of a national reinvention laboratory, which, by definition, has expressed an explicit interest in process innovation, and it is also perceived to be well-managed, having already institutionalized Total Quality Management (TQM), and achieved a number of impressive process improvements (e.g., the use of electronic data interchange [EDI] and bankcards for small and micro purchases, respectively). Because these procurement processes are acknowledged to perform relatively well to begin with, we have a good opportunity to demonstrate the use and utility of KOPeR and knowledge-based reengineering.

Table 1: Key RFP Process Measurements

Measure	Value
Process size	255
Process length	255
Parallelism	1.00 *
Handoff fraction	0.24
IT-Support fraction	0.08
IT-Communication fraction	0.00
IT-Automation fraction	0.00 *

* indicates theoretical minimum

RFP Process Measurements and Diagnostics

Table 1 summarizes a subset of the key RFP process measurements and diagnostics. The process size (255) measures the number of activities required for an RFP, the magnitude of which indicates that the process is relatively large; process size is generally related positively to activity-based cost (O'Guinn, 1991), whereas process length is thought to drive activity cycle time (Stalk & Hout, 1990). The parallelism measurement (size divided by length) represents a theoretical minimum for that measure; that is, the value (1.00) indicates that the RFP process flow is entirely sequential, with each of its activities performed in a strict linear fashion. The handoff fraction measures the percentage of process activities associated with organizational handoffs; handoffs are generally associated with work sitting in in-boxes and out-boxes—awaiting assignment, performance, reviews, and managerial approval—which adversely affects process cycle time. By comparison with other procurement processes, the value (0.24) obtained for the RFP suggests that much of the PALT associated with this process may be driven by handoffs.

The fractional metrics associated with information technology (IT) measure the density of three classes of IT in organizational processes: support, communication, and automation. The IT-Support measurement (0.08) is very low for the kind of knowledge- and information-work involved in the RFP process, and indicates that most process activities are performed manually. Worse, the IT-Communication fraction is indistinguishable from zero (to 2 decimal places), which indicates that nearly all process communications are paper-based. Moreover, the IT-Automation fraction (0.00) reflects the theoretical minimum for that measure, which indicates a labor-intensive process.

To summarize, the baseline RFP process represents a labor-intensive, linear sequence of manual, paper-based activities that are interspersed between numerous handoffs and reviews. The implication is that the process has a number of

pathologies and faults, which appear to adversely impact its cost and cycle time. Recall that the RFP process is *currently* considered to represent a well-managed set of acquisition activities. Having diagnosed these pathologies and faults, KOPeR next concentrates on reducing process linearity through a workflow transformation, and applies three IT-based redesign transformations to overcome the manual, paper-based, labor-intensive shortcomings of the process. KOPeR employs these transformations to generate the redesign alternatives below.

Redesign Alternatives

Referring back to the methodology depicted in Figure 1, KOPeR utilizes its measurements and diagnostics to predict one or more redesign transformations that have good potential to effect dramatic performance improvement through process innovation. The methodology also calls for a team of process experts from the procurement organization to review all of the KOPeR-generated transformations, using criteria such as feasibility, implementability, perceived benefit, and the like. Of the 40 or so redesign transformations predicted by KOPeR, the corresponding measurement information helps the team of experts to focus on three IT-based enabling technologies that are perceived to have the highest potential for improvement: a) procurement workflow systems, b) expert review systems, and c) knowledge-based composition systems. As an aside, the reader should note that current reengineering practice (e.g., Davenport, 1993) guides against process innovation based *solely* on IT-based transformations, yet IT continues to represent the *central* enabling technology for process redesign. These transformations are discussed in turn.

Procurement workflow systems. Workflow systems can enable the kinds of IT-based process support and communication that are absent from the baseline RFP process. Workflow systems provide a computer-based infrastructure for the routing, storage, and support of electronic documents, which can greatly reduce the time required for work to move between activities. The basic workflow system used to support the RFP process combines features generally associated with a database management system (DBMS) for indexed storage and retrieval of work documents at various stages of completion, along with those of an electronic communication application such as e-mail, which can be used to transmit work documents to the various organizational agents involved in a process. Additionally, the sequence of steps and agents involved in a process is generally enumerated beforehand, and used to automatically route work to the proper agent, when the work is required to be completed.

Other system capabilities can include templates to describe the overall flow of work in a process, along with on-line process "help" and reference information (e.g., regulations, contract clauses, etc.). A number of commercial workflow applications is available on the market, and several firms have expertise in customizing workflow applications to support a particular organization and process such as Navy RFP preparation. The implementation of workflow systems requires a considerable investment, however, not only

in computer hardware, software, and development, but also in personnel training, system maintenance, and process control. Interestingly, at the time of this writing, the process participants also indicate that a decision has been made to purchase, customize, and implement just such a procurement workflow system.

Review expert systems. Expert systems are capable of performing many of the reviews required by contracting officers and lawyers, and can enable the kind of IT-based automation of process activities that is missing from the baseline RFP process. The expert systems transformation addresses the various high-level reviews of RFP documents that are conducted by contracting officers (KOs) and legal representatives. These important reviews prevent errors and mistakes from affecting RFPs and subsequent contracting activities downstream in the acquisition process, and they require considerable skill and experience on the part of the KOs and lawyers involved. Hence, this requires relatively sophisticated AI technology required to reproduce the performance of such highly skilled experts.

Alternatively, a great many aspects of military procurement are governed by laws and regulations, which are articulated through the U.S. Code (USC), Federal Acquisition Regulations (FAR), Defense FAR Supplement (DFARS), and other widely distributed documentation; hence, many of the RFP reviews offer good potential for automation via (esp. rule-based) expert systems. Although complete automation is impractical (and probably undesirable), the review tasks can still be shared between human and computer agents. For example, following something of a "80/20 rule," if 80 percent of RFP reviews are routine and perfunctory in nature, then these can be assigned to the machine agent; the human experts (i.e., KOs and lawyers) can then handle the remaining 20 percent that are more difficult or complex. Such a scheme for (human/machine) task sharing has precedence in industry (e.g., engineering design, credit review, loan approval), and, although its transformation is predicated on relatively sophisticated AI technology, the regulation-based nature of the acquisition domain makes it nearly ideal for expert systems development. Indeed, this transformation in no way pushes against the frontiers of AI in computer science; rather, it represents the adaptation of established technology to the acquisition domain, and the kind of expert RFP review systems described here is well within current expert systems capabilities.

"Although complete automation is impractical (and probably undesirable), the review tasks can still be shared between human and computer agents."

Composition knowledge-based systems. Knowledge-based systems are similar in spirit to the expert systems above in that they automate tasks. The primary difference lies in the sophistication of knowledge-based systems, as they do not require performance at the level of an *expert* (e.g., KO, lawyer); rather, their level of knowledge and performance is lower, more on the order of an *analyst* or information worker like the Contract Specialist (CS). As such, the technological challenge is greatly reduced, even from that of the review expert systems above, yet the poten-

Table 2: Redesigned RFP Process Performance

Redesign Alternative	Cost	Cycletime
Procurement Workflow Systems	nil	28%
Review Expert Systems	11%	33%
Composition KBS	52% *	67% *

* Exceeds performance-doubling threshold.

tial for dramatic performance improvement remains. This makes the KBS redesign very attractive.

The work to be accomplished by such knowledge-based systems involves document composition. This generally entails activities such as (a) reviewing the background information and requirements associated with a procurement; (b) describing the supplies and services to be procured; (c) selecting the appropriate clauses, specifications, and standards; (d) outlining proposal instructions, schedules, and delivery information; and (e) using these elements to compose the proper RFP sections. Depending on the level of desired "intelligence" and functionality, a composition KBS can also be developed to make recommendations regarding contract types, incentives, and other higher-level activities, in addition to being embedded directly into the kind of procurement workflow system described above. Indeed, in the simulations that follow, such a procurement workflow system is *presumed* to exist, and provides a digital document infrastructure to support both RFP composition and expert review. As above, complete automation of the RFP document composition process is impractical (and probably undesirable), but extant KBS technology should be capable of incorporating most of the associated process activities (perhaps similar to the 80/20 split above).

Simulation Results

Simulation represents a powerful computer-based capability for evaluating the relative performance of numerous alternatives in a very short amount of time, and for gauging the effects of management decision-making alternatives—such as competing process redesigns—*before* committing time and money to a particular alternative (Hansen, 1994; van Mael, 1993). This point is very important, as many BPR methodologies omit this testing step, and jump directly from process redesign into implementation of a particular technology. The simulation of redesign alternatives is generally much less time-consuming and expensive than conducting pilot projects, particularly when a relatively large number (say three or more) of alternatives is involved; further, simulation is much, much faster and cheaper than implementing an *inappropriate* redesign alternative.

Table 2 provides a summary of simulation results for the three IT-based RFP redesign alternatives. The simulated performance of each IT-based redesign alternative is projected for a period of one fiscal year, and compared with that of the RFP process baseline in terms of activity cost and cycle time. The figures shown in the table reflect the percentage *process improvement* over the baseline RFP process. For purposes of significance, a performance-doubling threshold is established for "dramatic" (i.e., $2x$) improvement; that is, either cost or cycle time must be reduced by at least half (50%) to merit consideration as a process innovation. Alternatives that do not to at least double performance are better classified as CPI initiatives than as BPR transformations.

Workflow systems performance. First, notice that the workflow systems transformation effected only a modest (28%) improvement in cycle time, and had a negligible impact on process cost. Given the potential for improvement noted above, this may appear surprising, for workflow systems can greatly reduce the communication time between process activities, and provide the capability to automatically route work documents (at the right time) to the appropriate agents. These results also ran counter to the intuition of process experts and participants, as they considered this technology to have the greatest redesign potential. Through analysis, however, one discovers that workflow systems do not change the process *activities* that must be performed; rather, they change only the *environment and interface* within which the performance of such activities takes place. Such simple insertion of IT into an organizational process has been colorfully referred to as "paving the cowpaths" and "automating the mess" (Hammer, 1990). Using a workflow interface can sometimes even impede the performance of certain tasks.

For example, using a slow, tedious, or non-intuitive interface to consult on-line regulations or other references can require more effort than simply opening a (paper-based) desk reference (e.g., the FAR). Additionally, most workflow systems are configured with the electronic equivalents of in-boxes (e.g., task lists) and out-boxes, as agents must deliberately "open" their tasks before processing. Therefore, although the *communication* between process activities is much faster through workflow systems, without redesigning the underlying process itself, the actual *latency* of documents awaiting processing does not necessarily improve through the technology. Moreover, implementation of IT such as a procurement workflow system requires customization, training, maintenance, and support, in addition to the associated computer and network hardware and software costs. Based on these results, the procurement workflow system does not portend the kind of dramatic performance improvement expected through process innovation—at least not as a standalone alternative, or as an end in and of itself.

"Such simple insertion of IT into an organizational process has been colorfully referred to as 'paving the cowpaths' and 'automating the mess'" (Hammer, 1990)

Expert systems performance. The review expert systems redesign reduced

both cost (11%) and cycle time (33%) for the RFP process. Notice, however, that neither the cost nor cycle-time improvement exceeds the performance-doubling threshold. These results also appear surprising, and ran counter to the intuition of process experts and participants; they considered this advanced technology to have excellent redesign potential, and, given the fact that the KO and legal review tasks are *automated* through the expert systems, much greater improvements in process performance were expected.

"...the knowledge-based systems used for RFP document composition exceeded the performance doubling threshold for both cost (52%) and cycle time (67%)...."

Through analysis one discovers that, although these review tasks represent *critical* steps to ensure the quality and professionalism of RFPs, the reviews do not represent *high-leverage* activities for process redesign; in other words, the review activities are very important, but, as a percentage of the total process cost and cycle time, they do not represent the major contributors in terms of activities. Hence, only modest performance improvements can be expected to accrue through the automation of these RFP review activities.

Knowledge-based systems performance. In contrast with the modest performance improvements projected above for the workflow- and expert-systems redesign transformations, the knowledge-based systems used for RFP document composition exceeded the performance-doubling threshold for *both* cost (52%) and cycle time (67%), reflecting the kind of dramatic gains expected through reengineering. These results were also surprising and counter-intuitive, but for very different reasons. As noted above, the composition KBS transformation represents less technological sophistication with respect to the review expert systems, yet the payoff from this redesign intervention is dramatic. This provides an interesting insight into the relationship between technological sophistication (and risk) and process improvement (i.e., payoff), and casts some doubt on a widely espoused notion that major improvements require the most advanced technologies.

Through analysis one discovers that the relative success of this redesign transformation is attributable to the high leverage associated with RFP *composition* activities. Recall that this provides a contrast to the relatively low leverage observed through the RFP *review* activities from above. Specifically, unlike the RFP review activities that are automated through the expert systems transformation—which we indicated contributes a relatively low percentage to total process cost and cycle time—the RFP composition activities constitute the bulk of process tasks required to prepare RFPs. In other words, for this particular RFP process, the contract specialist's document-composition activities offer the greatest potential for improvement in terms of automation, and the KBS technology targets these composition activities directly.

Finally, it is important to reiterate that all three of these IT-based transformations neglect the integration of other, well-established enablers of process innovation (e.g., organizational design, and human resources; see Davenport, 1993). Although a number of corresponding, non-IT trans-

formations (e.g., case manager, process teams, delegation, empowerment, incentives) were identified by KOPeR, the team of process experts did not feel as though changes to the existing procurement organizational or human-resource structure would be feasible at the time of the investigation. As noted above, concentrating solely on IT-based transformations is not recommended by current reengineering practice. However, considering that the IT-based transformations above may still be *combined* with other (i.e., non-IT) enablers at a later date, the near-term prospect for effecting the magnitude of process improvement examined through this investigation must be exciting to today's procurement manager. Have faith, because current practice also recommends against trying to do everything at once.

Conclusions and Future Research

This article has investigated the redesign of the RFP process as conducted by one well-managed Navy procurement organization. The research shows that KOPeR proved to be successful in supporting the modeling, measurement, diagnosis, and redesign of the RFP process, and simulation played a critical role in the evaluation and comparison of redesign alternatives. Without the simulation results above, for example, other procurement managers may have been tempted to implement procurement workflow systems similar to the transformation described above, without an appreciation for the expected costs and limitations of this redesign alternative. Based *solely* on the procurement workflow system, such managers can anticipate negligible overall cost savings, and only modest improvement in cycle-time performance; hence, the prudence of this redesign decision (i.e., to implement *only* the workflow system) appears to be questionable. This result may provide useful guidance to the designers and decision makers now responsible for the DoD Standard Procurement System (SPS) development (SPS, 1996); the functionality of SPS is expected to be very similar to the procurement workflow systems described above.

This research also identified the review activities of contracting officers and legal advisors as target opportunities for automation through expert systems. KOs and lawyers represent well-paid, highly trained professionals that are critical to the RFP process, and automating their reviews through expert-systems technology was perceived to represent an excellent opportunity for process improvement. However, even with the workflow systems infrastructure (which KOPeR indicated was a necessary condition for expert systems' efficacy), this redesign transformation failed to exceed the performance-doubling threshold for process improvement. Particularly during times of tight fiscal constraint, it may be prudent to subordinate this redesign transformation to others that reflect greater potential for dramatic performance improvement.

"...the KBS transformation exceeded all other redesign alternatives in terms of dramatic performance improvement."

Specifically, the document-composition that KBS succeeded in more than halving both the cost and cycle time of the RFP process. Even though it uses less-sophisticated AI technology than the review expert sys-

tems, the KBS transformation exceeded all other redesign alternatives in terms of dramatic performance improvement. This highlights an exciting opportunity to further explore such composition KBSs, and possibly to couple this promising KBS technology with current efforts to develop and implement the next generation of procurement workflow systems (e.g., SPS).

Further, a system such as KOPeR may itself complement current efforts to capture other acquisition processes through computer-based modeling. Because of KOPeR's measurement-driven diagnostic capability, it has the potential to run "in the background" (i.e., as a non-user-directed process) of emerging process tools such as KnowledgeWorker (KnowledgeWorker, 1996), serving to suggest potential redesign transformations even as the basic process information is being captured and formalized through the system. Indeed, because workflow systems themselves depend on a (computer-based) process model to function, KOPeR could also operate "behind the scenes" (i.e., outside of the users' immediate views), diagnosing pathologies and faults in the underlying workflow-enhanced processes (e.g., helping to avoid "paving the cowpaths" and "automating the messes"). This represents another interesting area for future research.

"Finally, acquisition does not represent a solitary activity; rather, it involves the interaction between a procuring organization and one or more contractors submitting proposals and supplying goods and services."

As an immediate topic of related research, recall that this present investigation is designed to produce results that are broadly generalizable. This suggests that KOPeR and the RFP redesign transformations described in this paper offer good potential to innovate the RFP and like acquisition processes in other organizations. Given the regulatory nature of defense acquisition, one would expect to see considerable similarity among the procurement processes of various naval commands (e.g., NAVAIR, NAVSEA), service components (e.g., Air Force, Army), government agencies (e.g., DOE, DOT), and major corporations. Generalizing the results of this present investigation represents an opportunity to leverage the benefits of KOPeR and knowledge-based reengineering, which could help spark AI-based acquisition process innovation on a wide scale.

Finally, acquisition does not represent a solitary activity; rather, it involves the interaction between a procuring organization and one or more contractors submitting proposals and supplying goods and services. This interaction suggests that the kind of research described in this paper can be extended, for example through investigations to integrate the government-RFP and contractor-proposal processes. Such integration could lead to the discovery of additional opportunities for dramatic performance improvement through process redesign. In the spirit of acquisition reform and integrated process teams, research along this line also has the potential to reduce *contractor* costs (and cycle times) as well as those incurred by procuring organizations directly. Clearly, much work remains to be done, but KOPeR and its IT-based process innovations appear to offer great potential.

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DEVELOPMENT OF EMERGING TELEMEDICINE TECHNOLOGIES WITHIN THE DEPARTMENT OF DEFENSE: A CASE STUDY OF OPERATION JOINT ENDEAVOR IN BOSNIA

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For the past several years the United States Department of Defense has been using rapid prototyping as well as integrated product and process management to enhance military health care delivery using new telemedicine technologies. This paper outlines how these concepts are being used within the DoD Telemedicine Testbed to conduct proof-of-principle demonstrations and operational testing of emerging telemedicine technologies within real-world military operational environments. The authors consider these rapid prototyping and "rapid integration" efforts to be advanced development phases of the Army's formal telemedicine acquisition program known as Medical Communications for Combat Casualty Care and DoD's Theater Medical Information Program. They examine a case study of a real-time application of rapid prototyping in a contemporary operation—Primetime III, the telemedicine augmentation of medical units supporting Operation Joint Endeavor in Bosnia. The lessons learned from this experience are important to the eventual achievement of the strategic objectives of DoD telemedicine.

During the past two years the Secretary of Defense has articulated a strategy for a new system for Department of Defense (DoD) research, development and acquisition that shifts from traditional product-based research and development to a dynamic new framework characterized by rapid prototyping, concurrent as opposed to sequential engineering, reliance on commercial-off-the-shelf (COTS) technologies, horizontally and vertically integrated teamwork, and experimentation as the heart of integrated product and process management (DoD, 1996).

The DoD Telemedicine Test Bed has adopted these principles in its own inte-

grated framework for telemedicine research, development, and acquisition. In this system the Defense Advanced Research Projects Agency (DARPA) in partnership with the Medical Research and Materiel Command (MRMC) performs basic research and develops new technologies, such as telerobotic surgery, the personnel status physiological monitor, trauma and clinical care decision support systems, surgical simulators, and advanced diagnostic imaging systems. At its Prototype and Implementation Test Lab (PITLAB), the Army Medical Research and Materiel Command's Medical Advanced Technology Management Office (MATMO) integrates new technology developed by DARPA and COTS technologies into prototype systems tailored to satisfy military requirements as articulated by the Army, Navy, and Air Force user communities (Figure 1).

Prototypes are then evaluated by users in a variety of settings. These settings range from Advanced Warfighting Experiments (AWEs) staged at U.S. Army Battle Labs, or joint service exercises in which the Army, Navy and Air Force use test environments appropriate to their unique missions. Another option for blended telecommunications and advanced medical diagnostic technologies is the Center for Total Access, a joint initiative between the U.S. Army Signal Center and the Dwight David Eisenhower Army Medical Center at Fort Gordon, Georgia. Large field medical units at Fort Hood, Texas, and Fort Bragg, North Carolina, also offer excellent test beds for user experimentation and feedback.

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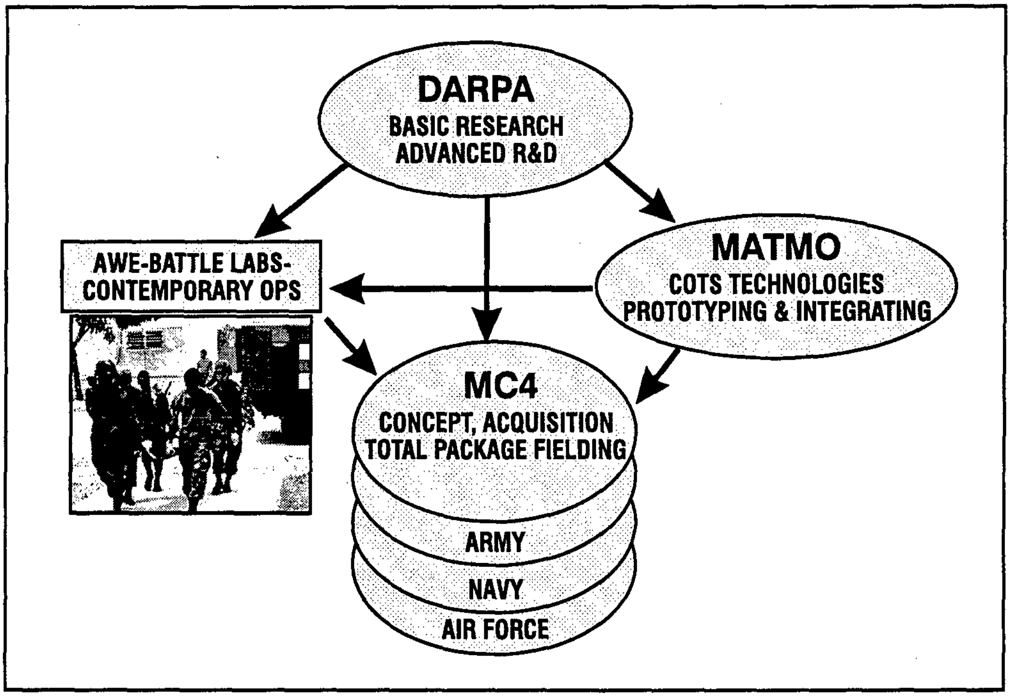

Figure 1. Department of Defense Telemedicine, Research, Development, and Acquisition

In addition, tertiary care regional military medical centers such as the Walter Reed Army Medical Center and Bethesda Naval Medical Center, both in Washington, D.C., Wilford Hall Air Force Medical Center in Texas, Tripler Army Medical Center in Hawaii, and Madigan Army Medical Center in the state of Washington have been active test sites for both peacetime and combat support telemedicine evaluation programs (Crowther and Poroputich, 1995; Lyche et al., 1995; Delaplain, Linborg, Norton, and Hastings, 1993). Contemporary operations such as the U.S. Armed Forces commitments to Somalia, Haiti, the Middle East, or Operation Joint Endeavor in Bosnia have offered a rich environment for rapid prototyping of integrated technology testing (Cawthon et al., 1991; Detreville et al., 1995; Gomez, 1994; Crowther and Poropatich, 1995), because they constitute a full range of health care services with networked telecommunications and information technology implementations ranging from far forward combat casualty care applications to subspecialty teleconsultation at the tertiary care medical centers. The DoD Telemedicine Testbed at Fort Detrick (MATMO) also leverages telemedicine experience and work done outside the DoD (Sanders and Bashshur, 1995; Galvin et al., 1995; Goldberg et al., 1994; Perednia and Allen, 1995; Mun, Alsayed, Tohme, and Wu, 1995)..

Within this rapid prototyping model, validated technologies destined for combat casualty care support are transitioned to a Program Manager (PM). The Army has recently established a PM for Medi-

cal Communications for Combat Casualty Care (MC4). The PM is responsible for acquisition of a completed technology system. He ensures that effective "process management" strategies are in place and that appropriate organizational, concept, doctrine, and training issues have been addressed prior to large-scale acquisition and fielding to operational forces.

The introduction of robust telecommunications, information technology and advanced diagnostic capabilities into health care has profound effects on established work patterns and responsibilities. Successful technology integration projects require comprehensive user requirements, organizational work process, and training analysis prior to large-scale acquisition and total package fielding (Appleton, 1993). The PM works closely with the user communities to ensure that important organizational assumptions and strategies regarding human–computer interfaces, work pattern changes, and personnel management are tested before there is widespread fielding.

"The introduction of robust telecommunications, information technology and advanced diagnostic capabilities into health care has profound effects on established work patterns and responsibilities."

The DoD can take advantage of a wide range of assets to further develop telemedicine. These assets are coupled with the DoD's relative immunity from a number of complex private sector impediments to telemedicine development. These impediments include restricted interstate medical licensing, lack of fee-for-service reimbursement, and unclear liability relationships (Perednia and Allen, 1993). These circumstances place DoD in a unique position to explore, evaluate, and continuously improve telemedicine technologies across a broad spectrum of clinical applications and user settings. This exploration could benefit both soldiers and civilians.

MEDICAL COMMUNICATIONS FOR COMBAT CASUALTY CARE (MC4)

The U.S. Army formally articulates its program for telemedicine support of ground forces as having five strategic thrusts. Far forward applications will provide front-line medics and small forward medical support units with still imagery, interactive videoteleconferencing (VTC), and diagnostic scopes. Eventually, far forward medics will have access to technology that can monitor the physiological status of individual soldiers and provide real time medical situational awareness of where and how medical assets are being used on the battlefield.

The Digital Field Medical Treatment Facility will provide ground support forces with telemedicine-augmented deployable hospitals. These hospitals will include capabilities for computed radiography, computed tomography, teleradiology transmission, VTC and diagnostic scopes, high-resolution still imagery, teledentistry, computerized hospital and patient information systems, Internet access, and enhanced wireless, hospital, and patient information management systems.

The Expert Tertiary Care Host provides forward deployed forces with access to specialty and subspecialty teleconsultation

from medical centers located in the continental United States. These requirements include the development of technology for regional medical centers to send and receive transmissions from remotely located forward deployed medical units, and to distribute VTC, image acquisition, and electronic patient information throughout the hospital. Telemedicine capabilities within medical centers will be based on the concept of clinical workstations that provide the clinician with an integrated telepresence that includes real time VTC, ubiquitous access to digital medical imaging, and patient information.

Telemedicine Sustainment ensures that a strategic telecommunications infrastructure is available to support telemedicine requirements from the continental United States to forward deployed locations around the world. The telemedicine sustainment thrust includes ensuring the availability of high-bandwidth satellite and terrestrial communications to deployed medical forces and research into the enhanced utilization of frame relay and asynchronous transfer mode (ATM) technologies to support multimedia, simultaneous medical transmissions of voice, text, and video. Another important area of concern is the development of enhanced medical compression algorithms that will allow the transmission of medically relevant information at lower bandwidths.

The last area, Emerging Technologies, supports the integration of what is now basic research into prototyping, advanced development, and eventually, fielding to operational forces. These technologies include the further development of advanced surgical simulators to enhance surgical training and planning; the integration of the personnel status physiological monitor into the broader U.S. Army Warrior Status monitor program; and the testing, evaluation, and fielding of the Life Support for Trauma and Transport (LSTAT) system, a self-contained critical care transport module with noninvasive, miniaturized diagnostic modalities, resuscitation, information management, and communications capabilities. The continued research into surgical robotics and expert decision support systems is another area of research interest that DARPA has funded for development.

Theater Medical Information Program (TMIP)

The Theater Medical Information Program (TMIP) is DoD's programmatic effort to fully integrate telemedicine and medical informatics systems support for deployed forces from all services. The concept is to provide a seamless continuum of information-based health care services from the most forward deployed forces around the world to the sustaining base DoD and Veteran's Affairs medical centers in the United States. To accomplish this, the TMIP will integrate and extend support to deployed forces for DoD's functional medical information systems such as the Composite Health Care System (CHCS) (originally designed as a peace-time inpatient and outpatient hospital information system), the Defense Blood Standard System (DBSS), the Transportation Command Regulating and Command & Control Evacuation System (TRAC2ES) and the Theater Army Medical Management Information System (TAMMIS). The Army's MC4 program is an integral part of the TMIP effort.

Context for Primetime III - Telemedicine Augmentation to Bosnia

When President Bill Clinton directed the deployment of U.S. Armed Forces in support of the Dayton Peace Accords in mid-December of 1995, one of the primary concerns of U.S. policy makers was the possibility of incurring casualties among U.S. ground forces. This concern was credible in the aftermath of U.S. casualties in Somalia, of the shooting down of a U.S. aircraft in the months prior to the Dayton Peace Accords, and numerous hostage takings (and releases) of United Nations soldiers earlier in 1995.

Various combinations of telemedicine technologies have been tested in joint service exercises, U.S. Army AWEs, on board deployed naval vessels, and within the peacetime Military Health Service System (MHSS). The U.S. military has also executed real world missions with these technologies in a wide variety of contingency operations over the previous five years.

Deployments in which telemedicine has been used to provide real world medical support include Saudi Arabia, Kuwait, Somalia, Haiti, Cuba, Panama, Croatia, and Macedonia. By the time of the Dayton Peace Accords, continued improvements in commercially available information technologies such as computer networking, data compression, and high-bandwidth telecommunications, linked with improved medical imaging and diagnostics technologies, offered military medical planners with an unprecedented opportunity to deploy integrated telemedicine capabilities far forward into a military theater of operations.

Consequently, the senior civilian and military leadership of the Military Health Service System decided in late December of 1995 to use a wide variety of telemedicine technologies to augment the U.S. medical units assigned to Task Force Eagle, the U.S. component of Operation Joint Endeavor in Bosnia and Hungary, as supported from the Landstuhl Regional Medical Center in Germany. The technical support task force formed to implement this intent is called Primetime III. The Commander of U.S. Army Medical Research and Materiel Command was delegated direct responsibility for the day-to-day supervision and execution of the mission.

Primetime III

Primetime III is a real-world rapid prototyping proof of principle demonstration for the MC4 and TMIP programs described above; this is a "first-shot" effort at deploying an integrated theater medical information solution tailored to the specific missions of Task Force Eagle and Operation Joint Endeavor.

The telemedicine solutions deployed are intended to allow medical commanders to satisfy five user defined requirements: a) to provide total patient accountability and medical regulating (tracking and scheduling patients through the evacuation chain) in real time from the first physician encounter; b) to keep evacuations and patient movement to a minimum and maximize return to duty; c) to deliver rapid world-class response to trauma; d) to leverage the expertise of medical specialists located in Germany and the United States in support of forward deployed units in Bosnia and Hungary; and, e) to provide medical leadership with enhanced situ-

ational awareness through networked information management systems and VTC at all levels of medical support.

Deployed Technologies

Primetime III has provided Operation Joint Endeavor medical units with the most robust set of telemedicine technologies deployed in a contemporary operation to date. Primetime III was planned and executed using rapid prototyping and "rapid systems integration" strategies; the Primetime III Task Force director employed a "brokering" strategy, bringing a variety of systems prototypes and prototypers together to produce a loosely integrated, nearly complete systems solution to the telemedicine and medical informatics objectives. This horizontally and vertically matrixed approach minimized organizational mass while optimizing function by leveraging the capabilities of DoD, Army, Navy, and Air Force units, the Defense Information Systems Agency (DISA), DARPA, and industry-academic partners including GTE, Northrop Grumman, Teleos, N.E.T., SAIC, United Medical Network, United Medical Network, Johnson & Johnson (Ethicon Division), CLI, Picturetel, Vector Research, and Georgetown University.

Units were fielded with Picturetel and CLI, Inc., high-resolution, 384-kilobyte-per-second (kbs), 30 frame-per-second (fps) systems capable of high bandwidth, real time interactive VTC. American Medical Development provided integrated digital diagnostic scopes sets to augment the interactive VTC.

Georgetown University designed, deployed, and installed a radiology local area network (LAN) system capable of providing filmless medical imaging and transmission of computed tomography (CT) scanning, computed radiography (CR), and full-motion, color doppler ultrasound.

United Medical Network developed a deployable telesurgical mentoring operating room suite that provides laparoscopic scope, overhead, and room view interactive, bi-directional audio and video transmission to support complicated surgical cases in Bosnia. A similar digital radiology and teleradiology system was employed onboard aircraft carriers offshore. This configuration of deployed hospitals, medical centers in Germany and in the United States, and shipboard hospitals, each configured with an internal radiology LAN interconnected to the other hospitals by a virtual wide area network (WAN), is the first radiology implementation of the seamless continuum of support envisioned by the DoD's TMIP program.

"Primetime III has provided Operation Joint Endeavor medical units with the most robust set of telemedicine technologies deployed in a contemporary operation to date."

The U.S. Air Force MEDSITE team from Brookes Air Force Base in San Antonio, Texas, in conjunction with the Army office for Defense Medical Information Systems at Walter Reed Army Medical Center in Washington, D.C., provided and fielded an enhanced deployable version of the CHCS, the DoD's integrated hospital information system. As deployed, CHCS(D) initiates computerized medical record keeping in the field; facilitates far forward delivery of laboratory, radiologi-

cal, and prescription support; and provides clinical electronic mail for collaborative care among widely dispersed clinicians. In another entrepreneurial effort, patient administration and medical regulating functionality of the Army's Theater Army Medical Information System, the CHCS(D), and the Defense Medical Regulating Information System (DMRIS) were significantly enhanced by a prototype PC/Internet-based real-time patient tracking system developed by the Army's Patient Accounting Systems and Biostatistical Agency (PASBA). Dubbed PARRTS (Patient Accounting and Real-time Reporting Transmission Systems), this prototype system allows military medical officers and tactical commanders to access computerized patient data and track evacuations. Primetime III also provides enabling technology to access online clinical databases via the military and civilian internet and to deliver teledentistry services.

The Uniformed Services University of Health Sciences Combat Casualty Care Research Center provided all on-site clinical training. The DoD Health Affairs TMIP office, in conjunction with DARPA, is providing the medical informatics integration strategy.

All these systems are supported by a collaborative MATMO, DISA, GTE telecommunications systems integration solution that provides satellite and terrestrial high bandwidth (approximately 1.536 Mb/s (megabits per second)) telecommunications support to forward forces at Taszar, Hungary, and Tuzla, Bosnia, 128 kbs International Maritime Satellite (INMARSAT) communications to dispersed clinics throughout Bosnia, and 384 kbs terrestrial connectivity to U.S. military medical centers in Washington, D.C., Texas, California and Hawaii.

PRIMETIME III CAPABILITIES LIST

FILMLESS, COMPUTED RADIOGRAPHY	Satellite T-1 1.536 Mb/s	CLINICAL E-MAIL
COMPUTED TOMOGRAPHY	Terrestrial T-1 1.536 Mb/s	TELERADIOLOGY GATEWAYS
HIGH-RESOLUTION VIDEOCONSULTATION	384 kbs 30 fps Interactive VTC	FULL-MOTION DOPPLER ULTRASOUND
DIGITAL DIAGNOSTICS	TCP/IP Medical Image Transfer	LAPRASCOPIC & ROOM VIEW TELESURGICAL MENTORING
STILL IMAGING		TELEDENTISTRY
HOSPITAL & PATIENT INFORMATION SYSTEMS		INTERNET ACCESS

MEDICAL SITUATIONAL AWARENESS

Figure 2. Primetime III Telemedicine and Medical Informatics Capabilities List

A combination of satellite and terrestrial telecommunications allows for connectivity with the USS *George Washington* and USS *Enterprise* aircraft carriers offshore in the Adriatic Sea. The carriers were equipped with similar capabilities for filmless radiology, teleradiology transmission, real-time, interactive VTC, and patient information systems (Figure 2).

Concept of Operation

Primetime III is an example of a mission-critical new technology integration project executed under intensive deadline pressure. Less than two months elapsed from the time the operation was ordered to the time the first augmentation was fielded at Landstuhl Regional Medical Center (LRMC).

The operation was originally organized into three telemedicine augmentation phases. A fourth phase was added to focus on the integration of emerging technologies, including the development of a transmittable and transportable electronic patient record. Other potential technology introductions include a prototype three-dimensional portable ultrasound, remote PC-based telepathology, and the LSTAT system.

In Phase One, the task force fielded telemedicine augmentation packages and supporting high-bandwidth communications to the LRMC in Germany, the 67th CSH in Hungary and the 212th Mobile Army Surgical Hospital (MASH) in Bosnia. The LRMC is a fixed facility regional center servicing active duty and family members in Germany; the 67th CSH and 212th MASH are mobile army hospitals deployed in the operational area, consisting of a combination of tents and hardened shelters. In addition, during Phase One, the USS *George Washington* was equipped and positioned off the coast of Bosnia in the Adriatic Sea. High-bandwidth telecommunications and VTC were also provided to military community hospitals and command and control elements in Germany.

In Phase Two, six operating base medical units in Bosnia were fielded and trained. These medical units are much smaller than the hospitals and are designed to support troop concentrations of a few thousand. They have a limited holding capacity for short periods of time, and received lower bandwidth, more easily deployable INMARSAT B (128 kbs) supported capabilities for VTC, still imaging, medical information system access, and at some sites, teleradiology transfer.

Phase Three is intended to provide telemedicine coverage for the remaining operating base medical units. At this writing the exact number and location of these units is being determined by theater medical commanders based on projected operational requirements in the later stages of Operation Joint Endeavor. The intent throughout the operation has been to provide total package fielding, including comprehensive new equipment training, maintenance and sustainment of telemedicine augmentation packages. Task force personnel have made multiple trips to Europe for forward fielding, installation, training, and follow-up.

The completed augmentation is an integrated, worldwide telemedicine-enabled health care delivery system (Figure 3) extending from remote clinic sites in Bosnia to major medical centers in the United States.

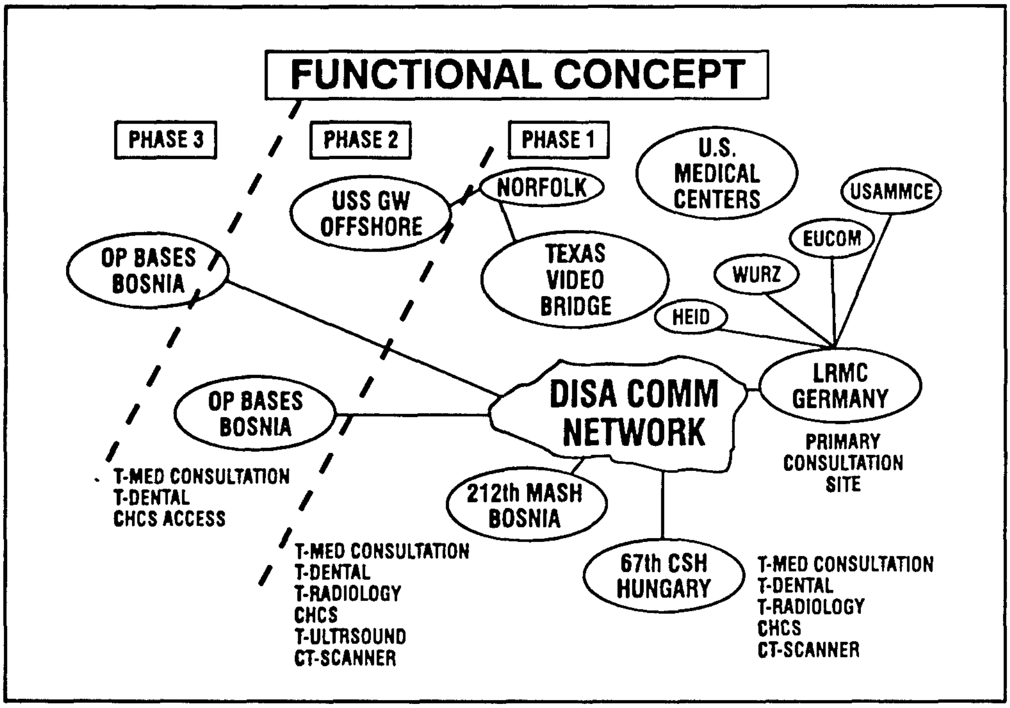

Figure 3. Functional and Operational Concept for Primetime III Telemedicine Support for Operation Joint Endeavor in Bosnia and Hungary

The medical centers designated to provide direct support to forces in Bosnia are organized to be able to provide 24-hour time zone arrayed teleconsultation support (Figure 4). One medical center (Walter Reed Army Medical Center) is located on the east coast of the United States. The second medical center (Wilford Hall Air Force Medical Center) is located in the center of the United States in another time zone. The Navy Medical Center in San Diego is located in California, and Tripler Army Medical Center is located in another time zone in the Pacific Ocean. Each hospital has a slightly different composition of specialist and core competencies. The combination of time zones and specialty populations offers, clinicians in Bosnia with a deep reservoir of teleconsultation support, continuing medical education, and medical information.

System Utilization

Initial results from the first four months of the operation are shown in Tables 1 and 2. Table 1 displays the recorded system use and Table 2 depicts the operational reliability (up-time) of the various technologies and functionalities employed. Radiology was the most widely used telemedicine application. Since the only radiologist present within the theater of operations was located at the CSH, physicians at the MASH had to use teleradiology for radiology procedures that required the presence of a radiologist. More than 800 X-rays were

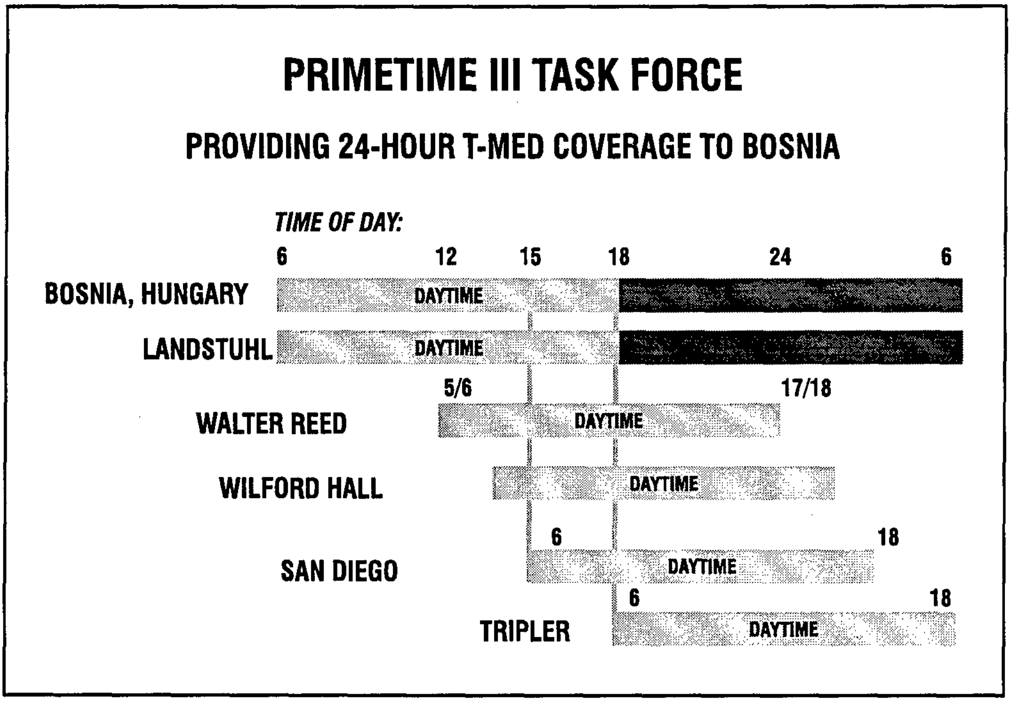

Figure 4. Medical Center Telemedicine Consultation Support for Operation Joint Endeavor, Organized to Provide 24-hour Coverage

transmitted from the MASH in Bosnia to a CSH in Hungary during the first four months of the operation. Similar use was made of the CT and ultrasound applications. Still image and full motion video consultation capabilities were used less. Several factors may account for these results. First, the caseload in Bosnia and Hungary during this period was very light. The troops deployed were in generally good health and there was no significant hostile action. Second, the training and op-

Table 1. System Utilization

APPLICATION	OP BASES TO LRMC	MASH/CSH TO LRMC/CONUS	67th CSH TO LRMC/CONUS	NAVY CARRIERS TO CONUS
Clinical VTC	4	28	39	36
Digital Radiography	N/A	3,969 Transfer 814	2,413	3,700 T-RAD
CT Scanner	N/A	207	37	Not Reported
Ultrasounds	N/A	98	Not Reported	8
Continuing Medical Education (CME)	0	40	3	2

Table 2. System Operational Reliability (% Up-Time)

SYSTEM	OP BASES	MASH/CSH	67th CSH	NAVY CARRIERS
Clinical VTC	No Data to Date	97%	100%	100%
High Resolution Still Image	No Data to Date	100%	N/A	N/A
Computed Radiography	No Data to Date	97%	97%	100%
CT Scanner	N/A	95%	95%	N/A
Ultrasounds	N/A	99%	98%	No Data to Date
Laparoscopic/Telesurgery	N/A	75%	N/A	N/A
Teledentistry	No Data to Date	N/A	100%	N/A
Medical Information Systems	No Data to Date	100%	100%	100%
Continuing Medical Education	No Data to Date	70%	75%	No Data to Date

erational support for the systems was initially inadequate. Third, the systems experienced significant end-to-end downtime due to insufficient technical support, slow delivery of repair parts, and initial inadequate network operational priority. In the case of high-resolution still imagery at the MASH, the capability was inadvertently omitted from Phase 1 implementation all together. (See communications and sustainment discussions below.) These shortcomings were subsequently addressed by the task force director but are strongly reflected in the initial system utilization results. The most significant uses of the full-motion VTC capability were for graduate medical education (GME) and career counseling. The laparoscopic surgery technique was highly accepted by the physicians in theater but due to lack of caseload there were very few surgeries conducted. The teledentistry system was also popular and easy to use but was not implemented until Phase 2, and therefore no initial results were available at this writing.

In the area of medical informatics, the success of the deployable CHCS hospital information system within the deployed hospitals was apparent from the start. It was professionally installed and adequately supported by the Air Force MEDSITE team; training provided was excellent and most of the health care providers had had previous experience with the system at their permanent duty stations, so user satisfaction was high. Since the forward areas order entry and results retrieval application of CHCS was not implemented until Phase 2, no initial results were available at this writing.

Like CHCS, the prototype PARRTS system was highly accepted by users both in the area of operations and in the supporting medical centers and commands. Even the service surgeons general and Assistant Secretary of Defense for Health Affairs in Washington, D.C., logged on to the PARRTS system via the Internet to obtain daily Operation Joint Endeavor medical situation updates. A total of 2,357 pa-

tients were registered in the system (i.e., treated at the MASH or the CSH) within the first six months of the overall operation.

Initial Lessons Learned

Space Communications and Network Management

The Space Communications and Network Management Team was responsible for the technical design and integration of the telemedicine network. This team created the detailed communications and forward deployed networking lay-down that provided for a commercially available, standards-based and scaleable infrastructure capable of supporting time-sensitive applications. The network was to have a multiuser, multifunctional architecture that maximizes infrastructure reuse. The network was to require minimal customization with maximized use of COTS equipment for rapid procurement, validation, and deployment. The network was also to have a minimum need for onsite communications staffing and a remote network management capability.

Within the time, cost, and operational constraints of Operation Joint Endeavor, all of these objectives were unobtainable. Rather than build a separate telecommunications network optimized to meet the aforementioned medical requirements, the task force shared bandwidth on the common high-bandwidth telecommunications network provided in theater. This network was not optimized for medical use, and was unavailable at times. Because it was not a dedicated medical network, medical personnel did not always have adequate visibility of the causes nor the final solutions to network telecommunications problems that affected the continuity of telemedicine enabled care.

A "stovepiped" medical telecommunications network, restricted to medical traffic and fully under the control of medical personnel, would probably have provided optimal functionality; medical personnel could have rapidly isolated, identified, and corrected network problems. In practice, this approach is not cost effective, it effectively inhibits information interchange between medical and nonmedical commanders, and is not operationally feasible from warship medical facilities. Shared telecommunications among medical and nonmedical requirements in deployed environments is the most feasible use of scarce bandwidth in the austere operational environments most likely to require telemedicine support. In the future, medical personnel will have to better communicate their requirements, telecommunications providers will have to better understand how medical requirements differ from other forms of communication, and better tools must be made available to medical personnel to monitor the performance of shared telecommunications pipelines. In this way, medical personnel will be able to anticipate problems and bottlenecks and proactively take corrective action to ensure that long-range com-

"Shared telecommunications among medical and nonmedical requirements in deployed environments is the most feasible use of scarce bandwidth in the austere operational environments most likely to require telemedicine support."

munications are available based on medical need.

A corollary to this finding is that medical organizations need to restructure to provide the expertise necessary to perform, or assist in the function of network conceptualization, development, and management in future operations. Even if military medical personnel had obtained the full remote monitoring, diagnostic, and network management capability that was sought, it is not altogether clear where DoD medical personnel would have secured sufficient skilled personnel to perform remote network management and troubleshooting 24 hours a day, 7 days a week. The DISA has traditionally provided long-haul strategic communications, but if the agency is to effectively support functional technologies such as telemedicine, providing a reliable back-bone communications infrastructure is not enough. More flexible and responsive network management and prioritization policies and procedures as well as end-to-end systems integration services and support are also essential. As health care delivery moves further into the integration of telecommunications and medicine, it is important that we think creatively about changed roles and responsibilities. One option is to leverage existing communications capabilities, such as call centers, in major medical centers.

"The telemedicine networks are established foremost to support the physicians that must deliver health care in an austere and demanding environment."

Clinical Operations and Training

From the outset, the Clinical Operations and Training were viewed as a key success factor of this rapid prototyping implementation. The Clinical Operations and Training Team was responsible for coordinating with and supporting the medical commanders in developing a comprehensive telemedicine program.

Telemedicine changes the familiar patterns of health care delivery and referral. These new patterns must be anticipated, trained for, and used in order to achieve desired clinical outcomes. The telemedicine networks are established foremost to support the physicians that must deliver health care in an austere and demanding environment. The clinical team is the physician advocate within the Primetime III task force.

The clinical team consulted widely in theater and at supporting medical centers to develop guidance on a wide range of clinical issues. Among these were the clinical utilization protocols for particular telemedicine technologies, medical center teleconsultation and scheduling policy, appropriate documentation for telemedicine enabled procedures, implementation of a technology acceptance and utilization strategy, and identifying continuing medical education (CME) use of the network.

The clinical team developed training plans and a training schedule that aligned with the projected phased site implementation time line. The training addressed not only the operation of the equipment, but also the full spectrum of protocol taxonomies and telemedicine applications for the provision of health care.

In practice, we found that the effectiveness of training varied between units. In

some cases, the task force had to redeploy trainers to provide additional sustainment training. This area—training development and execution—requires additional focus. Human-technology interface, work pattern changes, and medical efficacy concerns that many clinicians believe telemedicine raises are specific areas that require additional research and special attention. Overcoming these human issues are the most difficult element of most government related organizational-technological improvement programs (Candle, 1994).

A second difficult area is coordinating interactions between U.S. medical centers and the forward-deployed field hospitals. There are many opportunities for interaction between forward facilities and medical centers. In practice, the level of interaction between the U.S. medical centers and the units in theater varied widely. Some medical centers experienced fairly frequent contact, others rare contact. One of the impediments to greater contact may have been that we lacked concrete information and procedures for interaction between the two levels of care. An infrastructure of procedures and detailed resources available at each medical center and field treatment facility would probably facilitate more effective and frequent consultation. This too is an area that requires additional research.

At a minimum, training of clinicians on telemedicine must start in the peacetime health care delivery system and be sustained in routine medical practice, if it is to be optimized in deployed settings. Standardized training materials, not only in the operation of telemedicine equipment, but also in the process changes that telemedicine creates, must be developed. These new procedures must be used, and refined in routine medical practice and institutional training programs.

Though the task force devoted significant resources to the identification and resolution of technical problems, we may have underestimated the difficulty of managing human and organizational change in a compressed time frame under stressful conditions. These process changes are essential if these new technologies are to be used to their full advantage in enhancing access to and quality of care. Maneuvering full circle to the emerging concept of the Secretary of Defense for DoD Research, Development and Acquisition, we must devote equal resources to both "product" and "process" change in an integrated approach.

"In its early stages, a rapid prototyping development model is not intended to be a complete solution; therefore operational sustainment is not likely to have been fully planned and tested prior to prototype testing by the user."

Operations and Sustainment

Like training, operational sustainment and logistical support are as key to the success of rapid prototyping efforts as they are to traditional development, acquisition, and fielding processes, especially if prototyping is to occur in real-world situations. The major weakness of the Primetime III prototyping effort is the lack of integrated logistical support. Under traditional product acquisition methodologies, a complete operational and logistical sustainment package is developed and tested as part of the acquisition process. In its early stages, a rapid prototyping de-

velopment model is not intended to be a complete solution; therefore operational sustainment is not likely to have been fully planned and tested prior to prototype testing by the user. But if this user testing is intended to be carried out in a real-world environment, the prototyper must either provide "hand-holding" operational and logistical support or develop a sustainment package.

In the case of Primetime III, direct logistical support and indirect operational support was intended by the task force director. This proved to be insufficient, if not unworkable. Providing technical problem analysis, maintenance troubleshooting, repair parts, and component replacement support from MATMO headquarters in Frederick, Maryland, even through a network of government and contractor support personnel in-theater, did not work effectively. Repair parts and component replacements could not be procured within the United States and shipped into the theater of operations fast enough to be responsive to the medical task force needs. Likewise, user–operator confidence and proficiency languished each time the clinical operations and training team withdrew; when user technical proficiency languished so did use of the system for consultations. To remedy these problems, the Primetime III task force inserted permanent technical and operational support personnel on the ground to help personnel use the system, conduct troubleshooting and system repairs, and coordinate assistance from MATMO and the Primetime III contractors.

Clearly, rapid prototyping operations that are conducted in real-world environments, especially in remote ones, must be directly supported by the prototyper onsite or must be modified to provide adequate user operational training and an integrated logistical sustainment framework prior to deployment. MATMO and the U.S. Army Medical Command are currently developing plans for a provisional Deployable Telemedicine Units at Fort Bragg, North Carolina, and Fort Hood, Texas, as an organic component of the Army's operational Forces Command 44th Medical Brigade. The intention is to improve medical readiness and the effectiveness of future telemedicine deployments by fielding prototype telemedicine systems directly to operational forces for operational testing, training, and development of logistic support plans and procedures prior to deployment.

EVALUATION

No problem solution methodology is effective without an effective means of evaluating the results. The most widely accepted scientific approach to evaluation is a prospective approach with control groups. In the case of Primetime III the evaluation effort focused on operational, clinical, and technical aspects of the operation. The effort was intended to be prospective from the beginning; significant monetary, personnel, and materiel resources were devoted toward evaluation. This included hiring two independent contractor organizations to support the military's own evaluation effort: one to evaluate the technical feasibility and operational performance of the Primetime III systems; the other (hired by the DoD Telemedicine Evaluation Working Group [TWEG]) to support the Army Medical Department (AMEDD) Test Board in its own efforts to evaluate the operational and clinical aspects of the operation. The

AMEDD Test Board actually sent a team of military data collectors into the theater to observe the clinical use and operational performance of the Primetime III telemedicine systems, as well as the Primetime III task force team itself. A Lotus Notes database designed to capture key evaluation data elements was developed and fielded as part of the evaluation effort. The evaluation contractors relied heavily on data collected by the AMEDD Test Board team via the Lotus Notes system and on the contents of clinical and administrative e-mail to prepare their evaluation reports.

The evaluation team is responsible for ensuring that the in-theater data collection process, which will form the basis for evaluation analyses, is seamlessly integrated into the health care delivery process, and does not impede the health service mission. Questions that the combined clinical and technical evaluation will address include the following: Does telemedicine reduce the anticipated level of patient evacuations? Does it reduce turnaround time of radiological and laboratory reports?

Does telemedicine reduce the travel distance and time required to receive specialty care and consultation? Does it reduce patient admissions and increase the percentage of return to duty? Does it reduce cost of radiological film processing? Does filmless radiology reduce logistical requirements? Does telemedicine provide better patient imaging than current film-based processes? Does telemedicine reduce the loss of medical images (films)? Does it decrease the retake rate of radiological images, and does it reduce supply and personnel costs versus the development of film? Does telemedicine increase the efficiency and effectiveness of medical staff? Under what conditions is telemedicine most useful?

A related, but separate line of inquiry are questions of technical adequacy. For example, does the technology adequately support the clinical needs and processes? Are the components of the telemedicine augmentation sets interoperable? What factors affect the input of medical data? What factors affect the throughput of medical data? What factors affect data compression and pretransmission image modification? What factors affect image resolution and video display effectiveness? How does the technology effect the efficiency and effectiveness of the delivery of health care?

"The evaluation team is responsible for ensuring that the in-theater data collection process, which will form the basis for evaluation analyses, is seamlessly integrated into the health care delivery process, and does not impede the health service mission."

While no definitive evaluation reports have yet been submitted, early observations by the evaluation teams were most useful to the Primetime III task force director in initiating technical, operational, and clinical improvements in the system and to the support structure.

Some initial system utilization and performance data are shown in Tables 1 and 2. It is clear from this data that first, there is insufficient data for a robust evaluation of the clinical effectiveness of the telemedicine system—primarily because of the lack of patient workload in theater.

The troops deployed were basically healthy and there was virtually no hostile activity during the period of data collection. Therefore any evaluation of the usefulness of the telemedicine system for theater combat casualty care based on the data collected will be biased due to lack of caseload.

Second, while the system technical and operational reliability is certainly relevant to the evaluation of the prototyping effort, it automatically introduces biases into any evaluation assessment of the usefulness of the telemedicine system as a tool for health care. If the system functions poorly, clinicians will cease to use it and their active assessment of its utility as a health care tool will be negative.

Care must be taken in choosing operational environments for rapid prototyping testbeds to ensure that sufficient caseloads exist to adequately test the prototype system *and* to ensure that the prototype technology is sufficiently reliable so that the results of evaluation of the business process (in this case, telemedicine) are not biased by poor technical performance.

"These findings will inevitably lead to improved use of information technology and advanced disgnostics in health care as well as improved systems that better meet the needs of military and ultimately, civilian users of telemedicine and medical informatics capabilities."

The lessons learned above are preliminary assessments, and could change as the operation and evaluation continues, and more detailed findings become available. These findings will inevitably lead to improved use of information technology and advanced diagnostics in health care as well as improved systems that better meet the needs of military and ultimately, civilian users of telemedicine and medical informatics capabilities.

Summary and Conclusion

The Department of Defense is exploiting rapid prototyping and "rapid integration" of commercial off-the-shelf technologies to acquire and field test telemedicine applications in support of real-world military operations. Primetime III was organized by the Department of Defense Telemedicine Testbed at Fort Detrick, Maryland, to conduct a proof of principle demonstration and field tests of several telemedicine and medical informatics technologies in Bosnia and Hungary. Among the technologies and functional capabilities selected were high-resolution still imaging, full-motion video teleconferencing, digital radiography, computed tomography, real-time ultra sound, teledentistry, laparoscopic tele-surgery, teledentistry, electronic mail, Internet and World Wide Web access, and an integrated hospital information system. The most widely used application was digital radiography: a radiologist at only one of two deployed hospitals read and interpreted more than 800 X-rays transmitted via teleradiology in the first four months of the operation. Initially inadequate training, technical support and operational reliability as well as lack of caseload contributed to low system use for still imaging and full-motion video teleconsultation systems. Medical informatics systems in-

cluding a deployable version of the DoD CHCS and a prototype PARRTS were successfully implemented and favorably received by users.

An important element of the Primetime III augmentation is the evaluation of clinical and technical effectiveness of the deployed systems. Prior to deployment, a comprehensive evaluation plan that establishes performance metrics and a strategy to measure clinical and technical effectiveness and efficiency was designed.

Among the initial lessons learned were that the DoD Telemedicine Testbed needs to implement more structure into its rapid prototyping and rapid integration process if it continues to exploit real-world military deployments as telemedicine testbeds. The DoD needs more flexible and more effective policies and procedures for shared use of telecommunications bandwidth among medical and nonmedical users if telemedicine is to be effectively integrated into the military health service system without stovepiped, dedicated communications. The importance of clinical and technical training and establishing uniform telemedicine consultation protocols and procedures at both the sending and receiving ends cannot be overstated. Telemedicine changes both the way medicine is practiced and the way health care is provided logistically; this cannot be achieved without well-defined business practices and adequate training. Likewise, adequate technical support and logistical sustainment must be provided if physicians are to develop enough confidence in telemedicine systems to rely on them. Systems that don't work won't be used. Even in a rapid prototyping, proof of principle operation, adequate planning and procedures for providing user training and sustainment support must be implemented if patient care is involved.

The observations presented in this paper are only preliminary ones. It is too early to comprehensively answer the evaluation questions constructed for the Primetime III effort. Nonetheless, it is clear that the deployment in Bosnia will provide the U.S. military health service system with valuable information about the appropriate use of emerging telemedicine and medical informatics technologies in support of military operations. We are learning that rapid prototyping and matrixed organizational approaches that leverage distributed expertise while minimizing organizational mass can be effective at responding to rapidly changing requirements. Conversely, we are also learning how important it is to really understand user requirements and organizational change, if technology use is meet expectations. Most important, we have learned that it is easy to underestimate the work required to manage human factors that ultimately determine whether tele-medicine will be used to its full advantage to improve access to care, decrease the cost of delivery, and improve quality.

"Telemedicine changes both the way medicine is practiced and the way health care is provided logistically; this cannot be achieved without well-defined business practices and adequate training."

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TECHNICAL APPENDIX

Task Force Primetime (TFPT) III capabilities are implemented in an iterative-phased process. When complete, the augmentation will provide an integrated telemedicine network for Task Force Eagle medical units. The network will include the LRMC, the 67th CSH, the 212th MASH, 2 Brigade Operating Base (BOB) medical units (possibly 27), and access to the USS *George Washington* in the Adriatic Sea, off the coast of Bosnia.

The high data rate communications network will be capable of supporting:

a. High-resolution, diagnostic quality, remote video telemedical consultations.

b. Remote specialty surgery mentoring to MASH.

c. Digital diagnostic scopes.

d. High-resolution, color, still image capture.

e. CHCS access.

f. TAMMIS.

g. Clinical E-Mail.

h. Teleradiology.

i. CT scanning.

j. Full-motion, real-time ultrasound.

k. CR filmless radiology.

l. Teledentistry.

m. Telepsychiatry.

n. Medical situational awareness.

o. Preventive medicine consultations.

p. Infectious disease consultations.

q. Internet access.

At the discretion of the Task Force Eagle Commander, the integrated network (Figure 1.) also allows for access to fixed facility, tri-service medical centers in the United States. The network will also be designed to be capable of expansion and integration with the support of additional Air Force, Navy, and Allied forces medical units and leading edge technology insertions by DARPA, as necessary.

VOICE

Each location is equipped with a Micom Marathon switch and two telephones. Voice connectivity between the TFPT III locations is provided by three 256-kilobits-per-second (kbps) frame relay permanent virtual circuits provisioned through the IDNX nodes. Connectivity to the Defense Switched Network (DSN) is provided by extending six subscriber lines from the DSN switch at Lanstuhl to Foreign Exchange Office (FXO) modules in the Micom switch at the LRMC. The six DSN lines shall be

configured for Dual-Tone Multifrequent (DTMF) signaling.

VIDEO

Minimum of two VTC units are provided at each field location. VTC Unit One serves the clinic, and VTC Unit Two serves the Operating Room (OR). The VTC units installationed in the OR have been equipped with special camera units and wireless microphones. The VTC units at the Taszar CSH and Tuzla MASH are connected to ports A1 on two separate Teleos Model 20/A1T/2P Access switches, which, in turn, are connected to the network through one Primary Rate Interface (PRI) network interface each to the IDNX. The third Teleos Access switch installed at Taszar and Tuzla are spares. At the LRMC, two Teleos Model MCU-1T/16B/2P/4M Video Hubs are installed which, in addition to VTC interfaces, also have four Multipoint Control Unit (MCU) ports, which will be used to set up multipoint conferences.

VTC equipment from two manufacturers is used. The LRMC and Tuzla MASH will have CLI Radiance equipment, while the Taszar CSH will have PicTel units . It should be noted that while the CLI Radiance units are capable of setting up full-bandwidth conferences at 1.472 Mb/s (using 23 Basic Rate Interface (BRI) channels), the PicTel units at Taszar CSH are limited to a maximum of 768 kbps (12 BRI channels) conferences.

VTC connectivity between TFPT III locations is provided through the backbone transmission system that has the capacity to accommodate one point-to-point conference at 1.472 Mb/s or two point-to-point conferences at 768 kbps between any two field locations.

Off-net access to the German commercial network will be provided at Landstuhl by leasing 12 BRI Euro-ISDN lines from the Deutsche Bundespost (DBP). This access will be used to arrange conferences between TFPT III locations and Heidelberg, Wuerzburg or U.S.European Command (USEUCOM).

Off-net connectivity to the San Antonio MEDNET gateway will be established through a 384 kbps line (to be increased to 1.536 Mbps at a future date).

Multipoint conferences can be arranged for up to four locations using one of the two Teleos MCU-1T/16B/2P/4M units installed at the LRMC or for up to six locations by connecting the two MCUs together through one pair of the MCU ports, leaving three ports on each unit for VTC locations.

DATA COMMUNICATIONS

A local area network (LAN) serving teleradiology provided access to a high-speed (1.536 Mb/s) frame relay network through a Cisco router located in the communications equipment area and a LAN hub located in the teleradiology equipment room. Frame relay connectivity is provided by private virtual circuits (PVCs) with Data Link Connection Identifiers (DLCIs).

A LAN serving support systems such as TAMMIS, DMRIS, and e-mail is connected to a LAN hub located in the clinic and provided a 64 kbps access circuit to the N-level Internet protocol (IP) routing Network (NIPRNET) through the Cisco router and the Integrated Digital Network

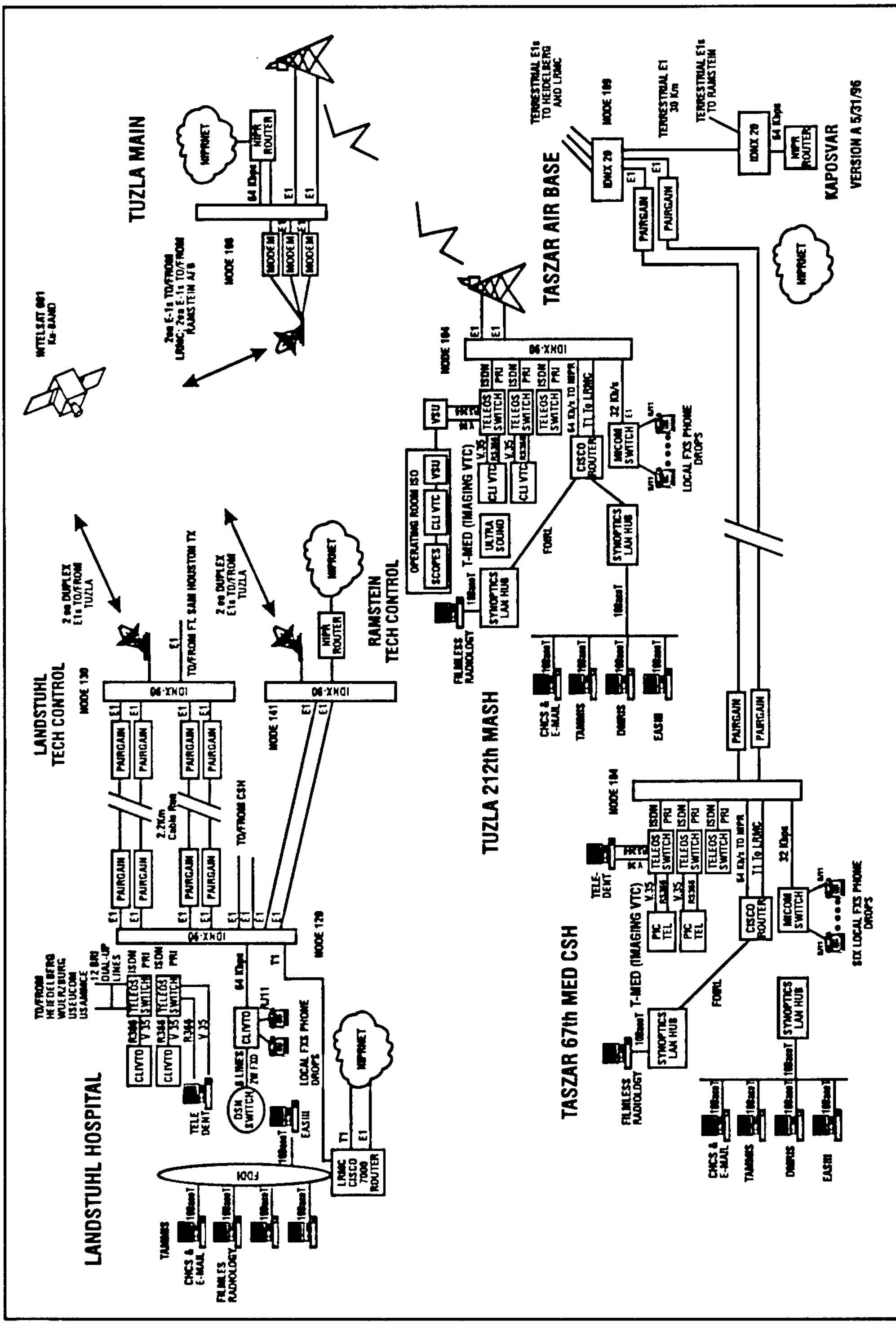

Figure 5. Primetime III Network Configuration.

Exchange (IDNX). Figure 5 shows the network configuration.

Teleradiology

LRMC

Landstuhl Regional Medical Center was established as a referral hub for secondary reading and as a site for clinical consultation with telemedicine. Equipment includes 2K diagnostic workstations and a 1K high luminescence image evaluation workstation, a dry laser printer with a print server, and digital imaging communication for medicine (DICOM) image gateway.

67th CSH, Hungary

The 67th CSH was established as a primary referral center for images obtained in the theater and diagnostic center for Hungary. Equipment includes 2K diagnostic workstations and 1K high luminescence image evaluation workstation, and a dry laser printer with a print server. Images are acquired on phosphor CR plates and processed in a laser processor. The equipment is connected to a Synoptics hub and to the WAN through a Cisco router.

212th MASH, Bosnia

The 212th MASH was established as a diagnostic center for Bosnia. Equipment includes 2K diagnostic workstations and 1K high luminescence image evaluation workstation, and a dry laser printer with a print server. Images are acquired on phosphor CR plates and processed in a laser processor.

The equipment is connected to a Synoptics hub and to the WAN through a Cisco router. The ultrasound machine is connected to the NTSC port of the telemedicine codec to provide real-time ultrasound.

Image Archive and Report Generation

All images are archived at the MASH. Images are initially stored on the 9Gig RAID array, then archived FIFO on optical disc.

Radiographic reports are entered manually by the radiologist at the CSH. A series of macros have been written to speed the process of report generation and approval. Reports are telnetted to the MASH from the CSH.

Technical Problems in Teleradiology

Occurrences in the teleradiology system are designated major or minor events. Major events are those that may or do have a direct impact on patient care. Minor events are abnormal occurrences with no potential for direct impact on patient care.

One major event had a direct impact on patient care: 16 images were lost from a CR study and the exam was repeated on conventional film. When the initial 16 images were selected to merge into one study there was a lack of disk space in the swap partition and the images were lost. This has been prevented by instituting procedural changes until a larger disk drive can be moved to the MASH.

A second major problem has been in the integrity of the communications link from the MASH to the CSH. This has been inoperable for as long as 72 hours. Since some of the voice lines and all Internet lines are carried over this communications

link, it is impossible to provide support during these inoperative periods.

Another major event was rain damage of the CR Identification Data Terminal when the tent housing this piece collapsed during a storm. The equipment has been repositioned into an isoshelter to prevent a recurrence.

There have been 11 reported minor events. These usually involve printing or delays in image transmission. They have been resolved without affecting patient care.

ACQUISITION REVIEW QUARTERLY GUIDELINES FOR CONTRIBUTORS

The *Acquisition Review Quarterly (ARQ)* is a scholarly peer-reviewed journal published by the Defense Acquisition University. All submissions receive a masked review to ensure impartial evaluation.

SUBMISSIONS

Submissions are welcomed from anyone involved in the Defense acquisition process. Defense acquisition is defined as the conceptualization, initiation, design, development, test, contracting, production, deployment, logistic support, modification, and disposal of weapons and other systems, supplies, or services to satisfy Defense Department needs, or intended for use in support of military missions.

RESEARCH ARTICLES

Manuscripts should reflect research or empirically-supported experience in one or more of the aforementioned areas of acquisition. Research or tutorial articles should not exceed 4,500 words. Opinion pieces should be limited to 1,500 words.

Research articles are characterized by a systematic inquiry into a subject to discover or revise facts, theories, etc.

MANUSCRIPT SECTIONS

The introduction should state the purpose of the article and concisely summarize the rationale for the undertaking.

The methods section should include a detailed methodology that clearly describes work performed. Although it is appropriate to refer to previous publications in this section, the author should provide enough information so that the experienced reader need not read earlier works to gain understanding of the methodology.

The results section should concisely summarize findings of the research and follow the train of thought established in the methods section. This section should not refer to previous publications, but should be devoted solely to the current findings of the author.

The discussion section should emphasize the major findings of the study and its significance. Information presented in the aforementioned sections should not be repeated.

RESEARCH CONSIDERATIONS

Contributors should also consider the following questions in reviewing their research-based articles prior to submission:

- Is the research question significant?

- Are research instruments reliable and valid?

- Are outcomes measured in a way clearly related to the variables under study?

- Does the research design fully and unambiguously test the hypothesis?

- Did you build needed controls into the study?

Contributors of research-based submissions are also reminded they should share any materials and methodology necessary to verify their conclusions.

Criteria For Tutorials

Tutorials should provide special instruction or knowledge relevant to an area of defense acquisition to inform the Defense Acquisition Workforce.

Topics for submissions should rely on or be derived from observation or experiment, rather than theory. The submission should provide knowledge in a particular area for a particular purpose.

Opinion Criteria

Opinion articles should reflect judgments based on the special knowledge of the expert. Opinion articles should be based on observable phenomena and presented in a factual manner; that is, submissions should imply detachment. The observation and judgment should not reflect the author's personal feelings or thoughts. Nevertheless, opinion pieces should clearly express a fresh point of view, rather than negatively criticize the view of another previous author.

Manuscript Style

We will require you to recast your last version of the manuscript, especially citations (e.g., footnotes or endnotes) into the format required in two specific style manuals. The *ARQ* follows the author (date) form of citation. We expect you to use the *Publication Manual of the American Psychological Association* (4th Edition), and the *Chicago Manual of Style* (14th Edition). The *ARQ* follows the author (date) form of citation.

Contributors are encouraged to seek the advice of a reference librarian in completing citations of government documents. Standard formulas of citations may give only incomplete information in reference to government works. Helpful guidance is also available in Garner, D.L. and Smith, D.H., 1993, *The Complete Guide to Citing Government Documents: A Manual for Writers and Librarians* (Rev. Ed.), Bethesda, MD: Congressional Information Service, Inc.

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Manuscript Format

Pages should be double-spaced and organized in the following order: title page, abstract, body, reference list, author's note (if any), and figures or tables. Figures or tables should not be inserted (or embedded, etc.) into the text, but segregated one to a page following the text. If material is submitted on a computer diskette, each figure or table should be recorded in a separate, exportable file (i.e., a readable .eps file). For additional information on the preparation of figures or tables, see CBE Scientific Illustration Committee, 1988, *Illustrating Science: Standards for Publication*, Bethesda, MD: Council of Biology Editors, Inc. Please restructure briefing charts and slides to a look similar to those in previous issues of *ARQ*.

The author (or corresponding author in the case of multiple authorship) should attach to the manuscript a signed cover letter that provides the author's name, address, and telephone number (fax and Internet addresses are also appreciated). The letter should verify that the submission is an original product of the author; that it has not been published before; and that it is not under consideration by another publication. Details about the manuscript should also be included in this letter: for example, its title, word length, the need for copyright notification, the identification of copyrighted material for which permission must be obtained, a description of the computer application programs and file names used on enclosed diskettes, etc.

The letter, one copy of the printed manuscript, and any diskettes should be sturdily packaged and mailed to: Defense Systems Management College, Attn: DSMC Press (*ARQ*), 9820 Belvoir Road, Suite G38, Fort Belvoir, VA 22060-5565.

In most cases, the author will be notified that the submission has been received within 48 hours of its arrival. Following an initial review, submissions will be referred to referees and subsequent consideration by the *ARQ* Editorial Board.

Contributors may direct their questions to the Editor, *ARQ*, at the address shown above, by calling (703) 805-4290 (fax 805-2917), or via the Internet at gonzalezd@dsmc.dsm.mil.

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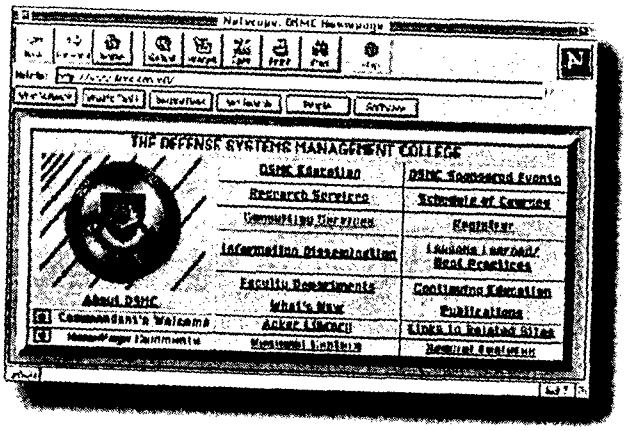

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Links to Related Sites

- ACQ Web (Office of the Under Secretary of Defense for Acquisition and Technology)

AR Net (Acquisition Reform Net)

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Acquisition Workforce

Call for Papers
Acquisition Review Quarterly
— Special Issue on Managing Radical Change —

The *Acquisition Review Quarterly* (*ARQ*) is planning a special issue with the theme "Managing Radical Change." We are pleased to issue this call for papers!

Although the *ARQ* generally maintains an explicit focus on the Department of Defense, one purpose of this special issue is to reach beyond its usual pool of researchers—to seek scholarly theoretical contributions and well-researched empirical papers of a basic and exploratory nature that may not be strictly focused on defense acquisition. The term *acquisition* refers to the enterprise processes required for planning, procuring, implementing, managing, and maintaining major systems; this might include, for example, information systems, factory equipment, transportation and communication networks, intelligence and research processes, and other significant systems, in addition to defense weaponry. Every enterprise that engages in strategic and capital planning, procurement, project management, policy making, logistics, systems engineering, operations management, outsourcing, performance measurement, decision making, collaboration, and even marketing is involved with some form or stage of the acquisition process.

The focus of this special issue is on managing radical change, which has roots in the literature on business process reengineering, change management, new public management, organizational design, revolutionary economics, leadership, systems analysis, policy, quality, and others. This focus comes at a time in which many enterprises and organizations have now had some experience with the kinds of *radical* change and fundamental process redesign that are often used to contrast reengineering and innovation with the more incremental modes of change generally associated with Total Quality Management and continuous process improvement. The crumbling of the Berlin Wall, combined with acquisition reform, technological innovation and downsizing present tremendous challenges in terms of the defense acquisition process, and one objective might be to draw from research focused on industry to help address these challenges.

This special issue seeks descriptive and prescriptive theoretical work that can be applied to the acquisition process, along with rigorous empirical work with clear generalizations and implications for defense acquisition. The *ARQ* is read by the most senior executives and policy makers in the government, so papers must have sufficient impact and importance to interest this group. We also seek to build a more solid theoretical foundation upon which acquisition research can build, so papers should be well-grounded in the appropriate literature, presented and formalized in a clear, concise, convincing and scientifically-defensible manner, and they should include compelling routes to generalization, replication, falsification and extension.

The *ARQ* is a refereed journal that is sponsored by the Department of Defense, and represents the leading source of executive and policy guidance pertaining to defense acquisition. This special issue will include professors David Lamm, Mark Nissen and Keith Snider, from the Naval Postgraduate School, as Guest Editors. Refereeing will be conducted in the usual double-blind process. Authors wishing to submit manuscripts should send them to the Editor of the *ARQ*, at the address below not later than 31 July 1997.

Manuscripts will be initially screened by the Editor of the *ARQ* to determine their appropriateness for review, and should not exceed 6000 words. To ensure anonymity, each paper should be submitted with a separate page that includes the author(s)'s name(s) and complete address, and the paper should include the title, abstract, keywords, body, complete set of references, along with tables and figures at the end. Authors are reminded to not refer to themselves or to their own work directly in the paper. All *ARQ* publications must follow the *Publication Manual of the American Psychological Association* format, and potential authors may wish to consult a recent issue of the journal for reference.

If you have preliminary questions on submissions to this *ARQ* Special Issue, contact these Guest Editors:

Dr. David Lamm
(DLamm@nps.navy.mil; 408-656-2775)

Dr. Mark Nissen
(MNissen@nps.navy.mil; 408-656-3570)

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